

With the commencement of the present volume (April) of *The Anatomical Record* a change has been made in the editorial management. At the recent meeting of the American Association of Anatomists a committee was elected to appoint editors for the two journals of the society, and to serve as an advisory committee for those so appointed. In the case of *The Anatomical Record* the choice fell on me, and it was decided that I should assume the duties of editor at once. Although given the privilege of selecting one or more associate editors, I have decided not to do so for the present, at least, trusting that fellow members of the society will be willing occasionally to give me the benefit of their opinions of certain articles quite informally.

The policy of the journal will not be materially changed, but an attempt will be made to hasten the publication of accepted articles, to adhere a little more closely to the original plan of *The Record*, and to differentiate it more clearly from THE AMERICAN JOURNAL OF ANATOMY.

In order to accomplish these results, it will be necessary to limit the length of the articles printed. No definite rules can be laid down, but in the opinion of the advisory committee papers of five or ten printed pages will usually be much more acceptable than those necessitating greater elaboration; while notes on laboratory methods, preliminary reports, etc., will be considered appropriate subject matter. All contributors are earnestly and confidently requested to coöperate in this policy.

At this time there are many articles already accepted by the former editorial board of *The Record* and ready for publication. These will, of course, be given precedence over later contributions. I have no hesitation in assuming their value, appreciating as I do, and as, I am sure, do all the readers of *The Record*, the careful and efficient work and the scientific discrimination of the former managing editor and his associates.

JOHN LEWIS BREMER.

All contributions and correspondence should be sent to

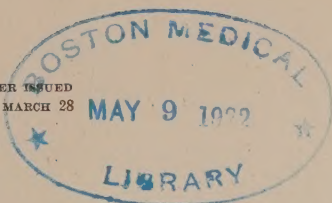
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Resumen por el autor, C. B. Moore,
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Infecciones de la uretra femenina.

A causa de su estructura, posición y mecanismo de desplazamiento, la uretra femenina es muy propensa a la invasión bacteriana. En ella se han encontrado una gran variedad de organismos. El gonococcus es el más importante, por su tendencia hacia la cronicidad y sus efectos nocivos. En las glándulas para-uretrales de Skene pueden presentarse infecciones supurativas crónicas, y también en las estructuras vestigiales de la glándula prostática, las cuales emiten pequeñas cantidades de pus de modo indefinido en la uretra anterior, sin que exista ningún síntoma local, por cuya causa no se descubren frecuentemente. La destrucción completa de estas glándulas, tal como puede conseguirse mediante el electro-cauterio, parece ser el único tratamiento que puede terminar de modo permanente las afecciones de dichas partes.

Translation by José F. Nonidez
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INFECTIONS IN THE FEMALE URETHRA

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TEN FIGURES

In order to understand better the infections which occur in the female urethra and especially their tendency often to chronicity and the frequency with which they escape detection, a clinical and laboratory study of female urethras has been made during the last three years, together with a review of some of the literature which might be of assistance. The work in the laboratory comprises some bacteriological investigations and histological examinations of urethras of the newborn, infants, and adults of different ages. For the clinical studies, which were done at the same time in the Women's Clinic of the Stanford University School of Medicine, a new instrument was devised which has proved very satisfactory for the purpose of examining and treating the anterior urethra. Photographs of the microscopic sections and the instrument are appended below.

Because of its structure and location, the female urethra is very prone to bacterial invasion and retention, and for this reason is of distinct clinical interest both to the obstetrician and to the gynecologist. Infections occur here to a great extent only during the child-bearing period and it is not an uncommon focus of infection during pregnancy.

The female urethra is a fibromuscular structure about 35 mm. in length, lying dorsally to the symphysis pubis and ventrally to the distal end of the anterior vaginal wall with which it is intimately associated. It is composed mostly of involuntary muscle fibers interwoven loosely with white fibrous and elastic tissue carrying numerous nerves and blood-vessels in its meshes, the corpus spongiosum. External to this appears two definite

muscular coats, the inner, or longitudinal, and the outer, or circular coat. The latter forms a large ring, the unstriped sphincter, in the region of the vesicular neck; its reinforcement with striped muscle makes the striped or voluntary sphincter. The mucosa lining the canal is stratified squamous epithelium to a varying extent in the anterior end, stratified columnar epithelium in the intermediate region, and a transitional variety in the posterior end near the bladder. At the meatus of some subjects, especially nulliparous ones, the mucosa is extended into two lateral folds, called by Kelly (1) the labia urethrae. They vary in size and shape and undoubtedly assist in protecting the urethra from bacterial invasion from without. The urethral meatus usually lies about 10 mm. from the anterior vaginal wall. In some subjects it lies even closer than this, sometimes a few millimeters. In the mechanism described below the meatus may come even to lie in a plane with the anterior vaginal wall.

The most important feature of the mucosa and the one giving rise to most, if not all, of the pathology is the glands, the most important ones of which are those of Skene. There are also many mucous or sinus glands found throughout its course. The latter structures are lined with short columnar epithelium and are sometimes called Littre glands. Skene's glands, usually two in number, lie beneath the mucosa posteriorly and near the meatus. They are individual, anatomic structures different from the crypts or sinus glands. Doctor Skene (2), of Brooklyn, in 1880, was the first one to discover these structures and realize their importance and to investigate their anatomy and some of their pathology. Dr. J. Kocks (3), of Bonn, and Prof. Max Schüller (4), a couple of years later, also investigated and described these para-urethral glands. The former considered them vestigial structures of the woffian tubules.

These glands have their genesis in the prostate which is present in both sexes (5). The first anlage of the prostate in the female appears in embryos of 50 mm.; in the male of 55 mm. At first the prostate consists of solid epithelial buds which extend into the surrounding mesenchyme from the epithelium of the urogenital sinus, an early anterior division of the cloaca. Part of

the anterior division of the cloaca goes to make the bladder and the urethra. These buds are most numerous on the dorsal surface, less so on the sides, and rarely on the ventral surface, although they may at times appear around the whole periphery. Those on the dorsal surface develop and branch, while those on the ventral surface remain simple and mostly degenerate. In the male these buds become enveloped in a fibromuscular mass to make the prostate gland. Some of the ducts which were not included in the formation of the prostate gland form accessory glands. According to Keibel and Mall, in the female embryo few glands are formed, three being the maximum number. These may undergo development and form the above-mentioned Skene's glands or ducts. This condition may possibly explain the different degrees of urethral infections in the female, at least to some extent. Since the glands are under retrogressive influences, they may not appear in some cases; in others they may be simple and shallow, in which case the infection is near the surface and therefore more easily cured; in others they may attain greater development, in which case infections become deep-seated and with poor drainage. This latter type leads to the chronic case described below which has been so difficult to cure.

In the embryo there are still other glands which develop in this region. These are the small sinus glands. They appear around the entire periphery of the urogenital sinus in the embryo of 60 mm. These glands have the character of those of Bartholin, but do not attain to the same development. The gland of Bartholin, also developed from the urogenital sinus, comes to lie outside of the urethra, for which reason it does not enter into the present topic. Thus it is revealed from embryonic studies that there is considerable glandular development in this region. According to the distribution of these glands, the urethra is sometimes divided into an anterior and a posterior urethra, the former being the glandular region and the latter the non-glandular region (6).

The structure of Skene's para-urethral glands is described as follows (7): Upon each side, near the floor of the urethra, are

two tubules extending from the vicinity of the meatus for 7 mm. to 15 mm. beneath the mucosa. The mouths of these tubes open upon the surface usually on either side of the median line about 3 mm. from the outer border of the meatus. The upper ends of the tubules terminate in a number of divisions which branch off into the muscular walls of the urethra. These racemose structures are lined by a compound epithelium composed of three layers. The deepest layer is composed of young roundish cells having large, granular nuclei which make up the major portion of the cells. Next above this is a layer of cells of a somewhat spindle shape with prominent nuclei. They are young cells at a more advanced stage than those of the first layer. The next, or outermost, layer is composed of fully developed columnar epithelium with distinct nuclei arranged at the base of the cells. At the mouth or duct of the gland the columnar cells give place to a squamous epithelium resembling that of the anterior urethra. The structure of the epithelium of these glands gives evidence of considerable functional activity, which function is the production of a rather viscid mucus. The purpose of this secretion is undoubtedly to lubricate and protect the anterior urethra. Because infections of these glands had been found only in adults between the ages of twenty and thirty-five years, it has been stated that they appear to reach their best development between these ages (1). In our clinic they have been found to occur in patients between the ages of twenty and forty-eight years inclusively. The fact that they do not apparently appear in ages under twenty remains to be explained. Possibly it may be due to a difference in the epithelial lining in very young patients. I have repeatedly examined the anterior urethras of young girls with chronic vaginitis, but have never succeeded in finding a suppurating focus in the urethra.

A great variety of organisms have been recovered from the human urethra (8): gonococcus, streptococcus, staphylococcus, diplococcus, colon bacillus, diptheria group of bacilli, pneumococcus, smegma bacilli, typhoid and typhus, pseudogonococci (an organism morphologically like the gonococcus, but Gram-positive in reaction), and tuberculosis, and spirochaetae. The

Micrococcus catarrhalis (a Gram-negative diplococcus resembling the gonococcus) has also been found in the urethra (9); also in the vagina (10), from which locality it may easily gain entrance to the urethra. A Gram-negative diplococcus having the form of the gonococcus, but with variations in size, has been demonstrated in preparations from fresh cultures (11). In smears taken from apparently normal urethrae, near the external meatus, we have always found some bacteria. Typhoid, typhus, and tuberculosis gain entry by invasion from within during the general infection of these diseases. A primary tuberculosis urethritis has yet to be definitely demonstrated. The inclusion bodies of Lindner (8), believed by many authorities to be the bacterium causing trachoma, have been recovered from the female urethra, the newborn of which patient had a conjunctivitis at the time. This same organism can be isolated from the infant's conjunctiva if smears are taken during the early onset of the inflammation. Virus from the mother's urethra, or from the infant's conjunctiva, or from a case of true trachoma will, when applied to the eyes of a monkey or human adult, produce trachoma. It is only when the germ gains entrance to the eye of the adult that true trachoma arises. So often has this been noted and by so many different observers that trachoma has been considered a venereal disease.

Infections in the urethra may be pathogenic or non-pathogenic, and also pyogenic or non-pyogenic. Because of its great prevalence and the extent of its ravages, the gonococcus is the infection of greatest importance. From the suppurating discharge expressed from the urethra Gram-negative intracellular diplococci can occasionally be demonstrated. But there are a great number of cases in which a great number of bacteria can be recovered without showing any presence of this bacterium, at least in smears made directly from the discharge. Knowing that the character of the gonococcus changes more or less during long habitation in the tissues, and also that a great variety of flora follow in its wake, chronic suppurating cases may be considered probably of Neisser origin unless otherwise demonstrated. Such a type of case may be shown in the following laboratory reports taken from the record of the Stanford Women's Clinic:

No. 66510. July 22, 1918. Purulent-looking discharge expressed from urethral gland. Laboratory report of smear: Many pus cells and a few Gram-negative intracellular diplococci.

August 29, 1918. Purulent-looking discharge expressed from urethral gland. Laboratory report of smear: Many pus cells and epithelial cells and a few Gram-negative intracellular diplococci.

January 29, 1919. Purulent-looking discharge expressed from urethral gland. Laboratory report of smear: Many pus cells and Gram-negative and Gram-positive bacilli; no Gram-negative intracellular diplococci.

March 3, 1919. Purulent-looking discharge expressed from urethral gland. Laboratory report of smear: Many Gram-negative bacilli; no Gram-negative intracellular diplococci.

In subsequent smears no Gram-negative intracellular diplococci were found, although a purulent-looking discharge could be expressed every time the patient was examined. Such a case clearly indicates a great difficulty encountered in any bacteriological search for this bacterium.

In some cases Gram-negative, intracellular diplococci may be present in the urethra without giving rise to any urethral signs or symptoms, as illustrated in the following record:

No. 74194. Cervicitis. Thick, mucopurulent discharge from the cervix. No discharge from the urethra; anterior urethra clear. Laboratory report: Cervical smear: Many endothelial cells and a few Gram-positive bacilli. No Gram-negative intracellular diplococci seen. Smear from anterior urethra: Gram-negative intracellular diplococci. Many Gram-positive diplococci and bacilli.

What organism this is we cannot say at present. It appears that this bacterium is either in the incubation stage or else has remained here without producing any pathology.

B. coli infections producing suppurating para-urethral glands have been described by Fellner (12).

The changes in the urethra following pathogenic infections may be divided into two classes: those due to simple inflammation and those due to suppuration. In the former the lesion is like that of inflammation of a mucous membrane. These usually disappear in time or else yield to urinary antiseptics, except possibly some few chronic cases affecting the intermediate region. The squamous epithelium of the anterior urethra does not offer

proper soil for the invasion of bacteria. Luys (6) has described the changes due to gonorrhoeal infections. Tuberculosis (13) and syphilis (14, 15) have their specific lesions, which are described under these diseases.

The pyogenic infections are very important because of their frequency and chronicity. However, it should be noted that there can be expressed from some female urethras a material which is not one of suppuration. Sometimes a thick, creamy discharge, sometimes cheesy in consistency, can be expressed in which smegma bacilli have been found. At times one may be able to express a considerable amount of this material from the urethra. Occasionally a thin or thick white discharge is seen in the anterior urethra or can even be expressed directly from a gland, a material looking like that seen in the vagina at the time. This discharge has apparently passed from the latter place and lodged in the anterior urethra or gained access to a gland. The stained smears from each locality are alike. This condition is demonstrated in the following record:

No. 78639. Moderately thick whitish discharge in vagina. Moderately thick whitish discharge expressed from gland in floor of anterior urethra, right side. Smears made from each locality. Laboratory report: Urethral smear: Examination shows many epithelial cells which are squamous in type and have been denuded in masses. No pus cells nor lymphocytes seen. Many bacteria of various types, including large and small bacilli and small diplococci. Vaginal smear: Shows moderate number of squamous epithelial cells, a few lymphocytes, but no pus cells; numerous bacteria of various types, including large and small bacilli and small cocci occurring singly, in pairs, and in masses.

On two subsequent examinations at intervals of seven days, the same discharge was expressed from the same region of the urethra. Because the excretion resembles that seen in the vagina, macroscopically and microscopically, it is probable that the process was initiated by extension from the latter place or vice versa, and apparently does not extend beyond that of desquamation. In the chronic cases with suppurating infections we have a condition in which the original surface infection has disappeared; the bacteria have penetrated into the glands which offer the best soil for bacterial growth. In these minute

epithelial pockets chronic inflammation with suppuration may go on indefinitely and without a local symptom. At every examination of these patients one or more drops of pus can be expressed into the urethral meatus from these suppurating glands.

When the duct of a suppurating gland becomes occluded there will be formed a para-urethral abscess which may vary from the size of a marble to that of a large walnut. In the larger abscesses the mucous membrane and vascular capillaries have been destroyed in places and the process has extended into the adjacent tissue. In this way blood sometimes becomes mixed with the pus.

An important point which may be considered here is the way in which the discharge from the urethra may be carried up into the parturient tract of an obstetrical patient. In his description of the function of Skene's glands, namely, lubrication during coitus, Kelly has described a mechanism of displacement and eversion of the urethra which may be seen to take place when a finger is introduced into the vagina. At the first contact the labia urethrae are separated. This opens the urethral orifice. The tendency of the act of penetration is to displace the distal end of the urethra dorsally. As the vaginal wall becomes impinged upon, the displacement will become even more marked and the urethral orifice directed into the vagina. Thus during the examination of an obstetrical patient the urethral meatus tends to become directed toward the examining finger. Pressure on the anterior vaginal wall expresses any infected contents of the urethral glands, which are then carried up into the vagina by the penetrating finger. For this reason, unless one be exceedingly careful, a digital examination of an obstetrical patient had better be done per rectum. Also by this same mechanism infections may be carried to or into the urethral meatus. This is probably the way in which *B. coli* enter the urinary tract in the newly married, giving rise to what is called by Sippel (16) 'Kohabitation Cystitis und Pyelitis.' No matter how slight the abrasion of the urethral meatus which is directed into the vagina during the act of penetration, colon bacilli, which are

commonly present in this region, become rubbed in and thereby enter the urethral lymphatics and ascend. Some of these cases of *B. coli* infection disappear spontaneously; others lose their acute character, if they had any, and continue without symptoms, a chronic condition with acute exacerbations of pyelocystitis, commonly called by the laity 'bilious attacks.' This is also a probable way in which pyelitis of pregnancy develops.

Whenever a suppurating discharge can be expressed from the urethral glands I do not think it worth while to treat the infection with antiseptic instillation into the urethra or even directly into the ducts of the gland. Many of the cases so treated continue to discharge pus with little or no interruption. If the patient is kept under observation long enough, it will sometimes be found that what was thought to be cured was only pus-free for a time and has returned to its former suppurating condition.

Anterior urethral glands can easily be destroyed with the electric cautery and the suppurating condition terminated if the cauterization is sufficiently done. Whenever it is certain that the discharge expressed from the urethra is pus the anterior urethra should be cocaineized with a 10 per cent solution of cocaine and the skenoscope (17) introduced. Sometimes one may be able to see the entrance to the ducts. With a finger in the vagina and pressure applied along the urethra, pus may be seen to appear at one or two spots on the mucosa. In one instance, I saw as many as three drops appear at the same time in different places, and in a lateral position, not in the usual position on the floor of the urethra. At times one will be surprised to find that he is unable to express any discharge from a urethral gland, although some emerged from the meatus on examination before the instrument was introduced. This may be due to the fact that all of it had been expressed either from a gland or from the anterior urethra where it was lying. To tell whether or not it has come from a gland it is necessary to make the examination with the anterior urethra exposed so that the definite locality of any discharge may be seen. In case of failure to express any excretion for the reason just mentioned, the patient may be requested to return for another examination in a few days. The

instrument is then introduced for the preliminary search. The gland will be found to have filled again, especially so if pus had been found, and the discharge will be seen to emerge from its orifice on pressure. With a small wire a search is made in each drop of pus for the entrance to the duct into which the wire is passed as far as possible. This will act as a guide to direct the passage of a small wire electrocautery. Cauterize until as much tissue is destroyed as one thinks advisable. Failing to find the entrance to the duct one may cauterize the region with no guide other than the eye. If on a subsequent visit the treatment has been found to be unsuccessful or pus has appeared from another locality, the treatment should be repeated. I have never seen any ill effects follow this treatment and no recurrence after the second cauterization, which is usually more thoroughly done than the first one. Healing is very prompt. Also, I have never seen any suppurating gland further than a few millimeters from the meatus; never beyond easy reach of the cautery, and never more than one or two in number, on one occasion three. This fact, together with Keibel's and Mall's embryonic studies, leads me to believe that all of these cases are those of skenitis.

Para-urethral abscesses which cannot be emptied through the duct should be treated surgically by incision and drainage.

I wish to thank Dr. Frank Ellsworth Blaisdell for his help and assistance in examining the histological sections and for his contributions of microphotographs which accompany this paper. Thanks is also due others of my confreres whose interest has been an encouragement.

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PLATE 1

EXPLANATION OF FIGURES

- 1 Cross-section of a female urethra near meatus of a newborn baby. *G*, glands; *U*, urethral canal. Abundant squamous epithelium.
- 2 Higher magnification of a region on figure 1. All sections of this specimen show this type of epithelium.
- 3 Cross-section of the whole specimen of a female urethra near meatus of a nine months' baby. As disclosed in embryonic studies, the glandular budding is greater on the dorsal side.

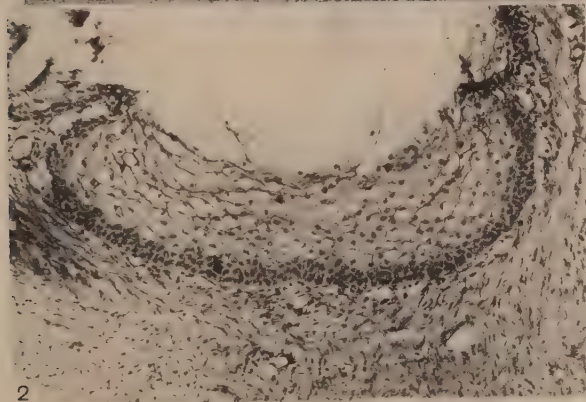
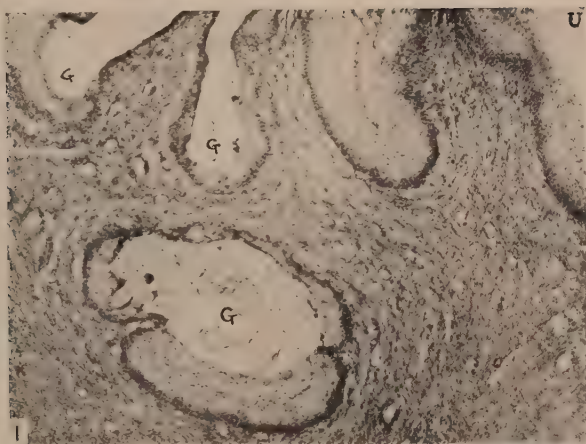


PLATE 2

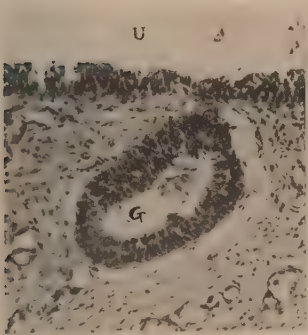
EXPLANATION OF FIGURES

4 Cross-section of a female urethra near meatus of a nine months' baby; made from a region of figure 3. *G*, gland; *U*, urethral canal.

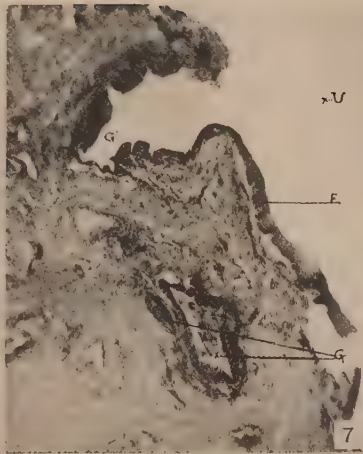
5 Cross-section of a female urethra near meatus of a twenty-three-year-old subject. Epithelium is squamous. This is undoubtedly a Skene's gland. *U*, urethral canal; *D*, duct; *G*, gland.

6 Higher magnification of a region on figure 5, but made $\frac{1}{100}$ mm. posterior to the section made of the latter. This section shows columnar epithelium of the urethral canal, *U*, and the gland, *G*.

7 Cross-section of a female urethra near meatus of a forty-three-year-old subject. *G*, gland; *E*, epithelium; *U*, urethral canal.



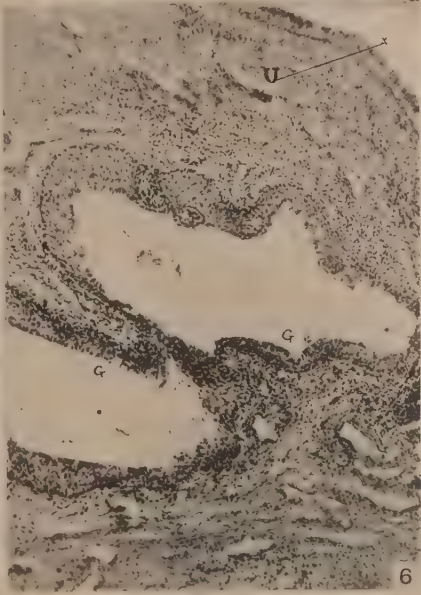
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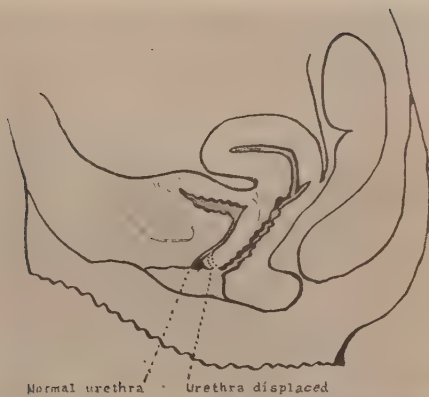
PLATE 3

EXPLANATION OF FIGURES

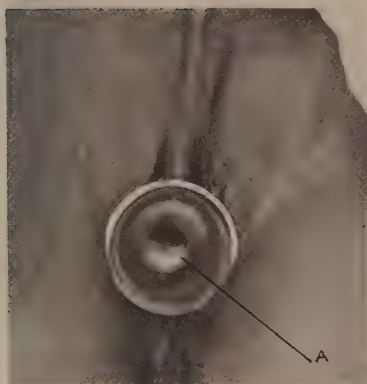
8 Drawing of a sagittal section through the center of a female pelvis representing the urethral displacement on vaginal penetration.

9 Instrument in position for examination and treatment. Exposure of drops of pus (A) in different localities of the urethra in different subjects.

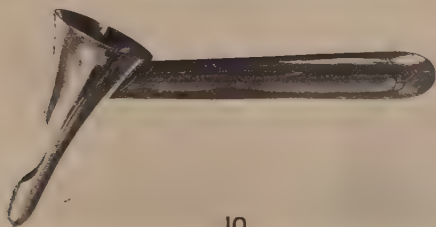
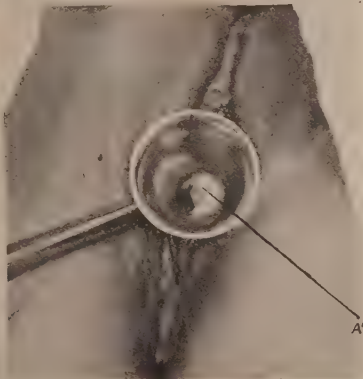
10 Skenoscope.



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Resumen por el autor, Richard E. Scammon,
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Un sencillo aparato de calcar para hacer reconstrucciones
topográficas.

Este aparato ha sido ideado para hacer reconstrucciones gráficas de fetos y otros objetos pequeños. Consiste esencialmente de dos partes: Una placa de vidrio cuadrículada, cuyas líneas distan entre sí un centímetro, colocada sobre un tablero, y un ocular con un eje óptico establecido mediante un pequeño orificio superior y una cruz formada por dos cerdas cruzadas, situada inferiormente.

En la base del ocular se ha cortado un cuadrante para permitir la orientación de aquel con referencia a las líneas de la cuadrícula. Los bordes del cuadrante son biselados y divididos en una escala milimétrica para medir pequeñas distancias. Los ejemplares que se desea reconstruir se colocan sobre el tablero de la base, y después de orientarlos con referencia a la línea basal de la cuadrícula dividida en centímetros, se dibujan en papel cuadrículado por medio de una serie de lecturas sucesivas tomadas con el ocular.

Translation by José F. Nonidez
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A SIMPLE TRACING APPARATUS FOR MAKING TOPOGRAPHIC RECONSTRUCTIONS

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THREE FIGURES

The study of certain phases of the anatomy of the fetus and infant is hindered somewhat by the lack of any simple method of making topographic reconstructions of the various organs and regions. Graphic reconstruction from microscopic sections, which is so successful in embryologic work, is generally impracticable here, for the preparation of even a few sets of serial sections of this material requires an almost prohibitive amount of time and labor, and the thorough decalcification necessary for the larger specimens usually causes serious shrinkage and distortion in the process of embedding. The usual methods employed in the study of adult topography are also inadequate for this work. Topographic reconstructions of the adult are generally made either by graphic reconstruction from free-hand transverse sections after the method first suggested by Henke or by plotting from fixed points which are established by setting long pins or skewers in the body in certain definite positions before dissection is begun. But to make accurate reconstructions of the smaller structures of the fetus and infant the sections must be cut so thin that they are extremely fragile and subject to distortion. And the fixed point method is very inconvenient both because of the difficulty in placing the pins firmly in position in the delicate tissues and because these pins make the subsequent dissection of the smaller regions almost impossible.

The apparatus which is described here was devised to overcome some of these difficulties, and after a considerable trial has been found sufficiently useful to warrant the publication of

an account of it. It consists essentially of a tracing stand, covered by a glass grating, and an eyepiece.

The stand is shown in figure 1. Its base is a slab of hardwood, 25 inches long, 17 inches wide, and 1.5 inches thick. Seven inches above this base is a sheet of heavy plate glass inclosed in a strong hardwood frame, which is supported at its corners by four brass rods. At one end these rods or legs are connected with the frame by hinges and firmly attached to the base-board

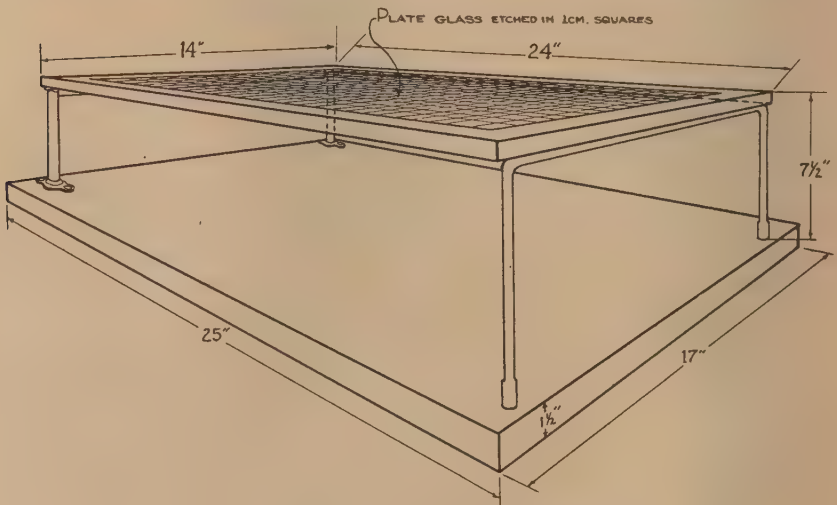


Fig. 1 Stand of reconstruction apparatus.

with screws. At the other their upper ends are screwed to the frame of the plate, but their lower ends are covered by rubber caps which rest freely on the base-board. This permits the frame to be raised so that large objects may be easily placed on the base-board below.

The glass plate is ruled with a centimeter grating and the lines of this grating are numbered or lettered consecutively at its margin. The middle longitudinal and the middle cross line of the grating are ruled a little heavier than the others and are filled with pigment to distinguish them as base lines (fig. 3).

The eyepiece is a brass tube 4 inches long and 0.8 inch in diameter (fig. 2, *A*). Its upper end is closed by a screw cap which contains a central pinhole opening (fig. 2, *B*). At the bottom of the tube are cross-hairs of spun glass or very fine wire which are set a little above its lower opening and cross in the optical

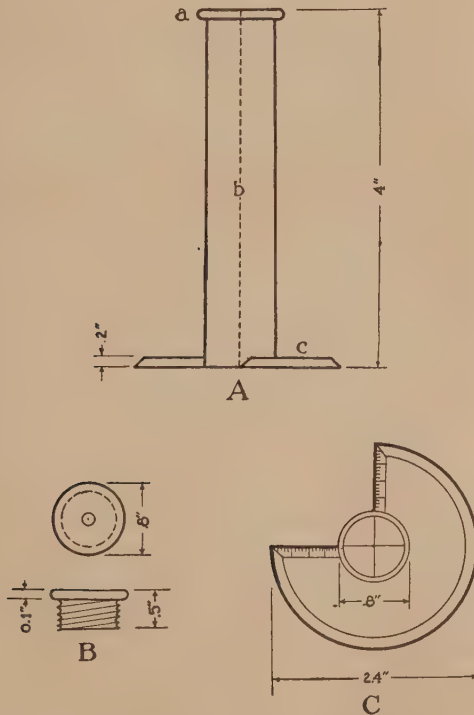


Fig. 2 Eyepiece of reconstruction apparatus. *A*, entire eyepiece; *B*, detail of screw cap with pinhole opening; *C*, detail of quadrant base.

axis of the tube directly in line with the pinhole opening in the cap. The lower end of the tube is set in the center of a circular plate of brass 2.4 inches in diameter and 0.2 inch thick. One quadrant of this base is cut away, its margins being so adjusted that they fall directly in line with the cross-hairs of the eyepiece.

The edges of the quadrant are beveled and are graduated in millimeters, the zero points of the scales lying exactly 1 cm. from the optical center of the eyepiece (fig. 2, C).

The method of using the apparatus is simple. The specimen to be reconstructed is fixed firmly in a tray or better set in a base of plaster of Paris or hard wax. It is then placed on the base-board and adjusted so that its midline corresponds approximately with the midline of the grating on the glass plate above it. Orientation points are then established by marking the specimen with dots of indelible ink or by setting small pins in it. At least three such points should be established as far apart as possible and in regions which will not be disturbed in the course of the subsequent dissection. A large sheet of coördinate paper is now numbered to correspond with the numbering of the grating, and base lines corresponding to those of the grating are drawn upon it. The exact position of the orientation points and the outlines and superficial landmarks of the specimen are now determined by successive readings with the eyepiece which is passed over the grating. As these determinations are made they are recorded in their proper places on the coördinate paper, and the first plot giving the outlines of the specimen is completed by connecting these points. After the outline is made the specimen may be dissected layer by layer and as the different structures are exposed they may be outlined in their proper positions on the plot by replacing the specimen under the grating, adjusting the orientation points to their recorded positions, and taking the necessary readings with the eyepiece. With a little practice this process can be carried out quite rapidly. Readings with the eyepiece to half-centimeters can be made directly from the lines of the grating and readings to half-millimeters by using the scales on the margins of the quadrant. The specimen should be strongly illuminated when the readings are made. Orthographic projection is assured by the use of the eyepiece with a vertical optical axis established by the pinhole opening and cross-hairs. It is possible to make the reconstruction at any magnification desired by modifying the scale of the coördinate paper.

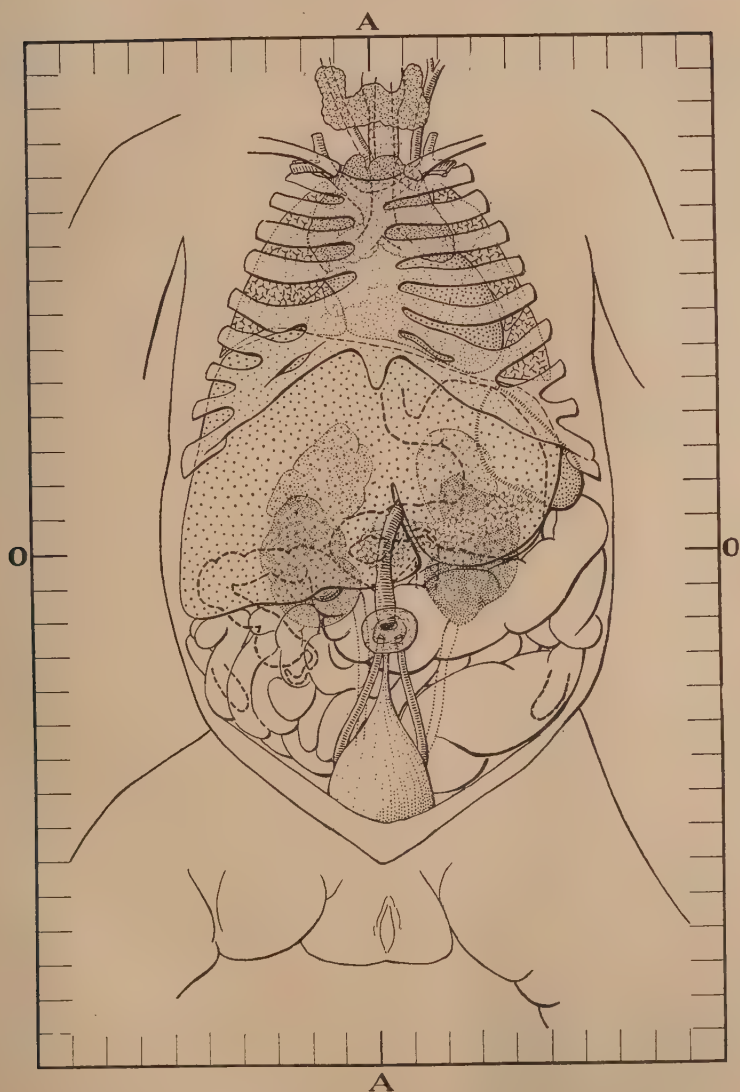


Fig. 3 Reconstruction of the abdominal and thoracic viscera of a full-term newborn infant. Made by H. J. Bower and W. C. Stillwell with the apparatus herein described. The reconstruction has been retraced and reduced to one-half the original (natural) size. The centimeter scale of the grating is shown at the margins of the drawing. A-A and O-O are the longitudinal and cross base-lines.

The chief sources of error in making reconstructions of this kind are due, first, to changes in the form of the specimen which may occur in the course of dissection and, second, to variations caused by the improper adjustment of the eyepiece. The first may be avoided, in a great measure, by partially embedding the specimen in a firm base of plaster or wax as mentioned above and by care in dissection. The second can be entirely eliminated if care is taken to see that the margins of the quadrant are either parallel or at right angles to the lines of the grating before each reading is made.

An example of a reconstruction by this method of the thoracic and abdominal viscera of a full-term stillborn infant is shown in figure 3. The original plotting has been retraced and inked, the published figure being one-half the size of the original.

Resumen por el autor, Richard E. Scammon,
Universidad de Minnesota.

Nota sobre la relación entre el peso de la tiroides y el del timo
en el hombre.

La variación de peso del timo y la tiroides en adultos jóvenes, en apariencia normales (determinados por los datos de Dustin y Zunz) es muy grande. Los pesos de estos órganos demuestran la existencia de una correlación ligeramente negativa en la madurez temprana. Los pesos del timo y la tiroides del recién nacido varían también considerablemente, pero presentan una ligera correlación positiva. Las conclusiones de Dustin y Zunz sobre el valor de estos datos como prueba de una correlación funcional entre el timo y la tiroides no reciben confirmación en los estudios del autor.

Translation by José F. Nonidez
Cornell Medical College, New York

A NOTE ON THE RELATION BETWEEN THE WEIGHT OF THE THYROID AND THE WEIGHT OF THE THYMUS IN MAN

RICHARD E. SCAMMON

Institute of Anatomy, University of Minnesota

In a recent publication Dustin and Zunz (1) have recorded some interesting observations on the weight of the thyroid and the thymus in early maturity. Their data are quite unique, consisting of weighings of the thyroids and thymi of thirty-eight individuals who, with one exception, died within forty-eight hours after receiving wounds in battle, and who came to autopsy within twelve hours or less after death. We are thus furnished with a series of records of the weight of the thymus in presumably normal young adults which greatly improves our knowledge of the later ponderal changes of this organ.

Dustin and Zunz have analyzed this material by means of tabulations and a graph in which the thymus weight is plotted against the thyroid weight. They found a negative correlation between thymus weight and thyroid weight in man, and they conclude that their results support the experimental findings of Gley (2) and others who have observed an increase in the thymus following thyroidectomy in amphibia.

Although this series of cases is very small for any statistical study, its unique character and the importance of the conclusions which have been drawn from its examination seem to warrant its further analysis by some of the simpler biometric methods. Accordingly, the standard deviation and the coefficient of variation have been determined for the thymus and thyroid in the series and also the coefficient of correlation between the two organs. These determinations were first made for the entire series of cases as given in the original article, and second for the same series with the omission of four cases which seem to be of doubtful value.

In the complete series the average weight of the thyroid is 32.0 ± 2.4 grams, the standard deviation 21.8 grams, and the coefficient of variation 0.68. The average thymus weight is 15.6 ± 0.7 grams, the standard deviation 7.07 grams and the coefficient of variation 0.45. The coefficient of correlation between the thyroid and the thymus is -0.265 with a probable error of ± 0.102 .

The second calculation was made from the series after the omission of the following cases.

Case 1, in which the weight of the thyroid was 134.54 grams, nearly four times the average weight of the group and over two times the weight of the next member of the series. It can scarcely be doubted that this great enlargement was associated with thyroid disease.

Cases 2 and 11, in which there was a complete involution of the thymus. As these cases were individuals aged twenty-five and twenty-eight years, respectively, it is most probable that the thymi had undergone accidental involution, presumably in some previous illness.

Case 38 was a youth but fourteen years old and cannot be properly included with a series of young adults, since the thymus undergoes profound weight changes in adolescence.

In the selected series, with these four cases omitted, the average thyroid weight was 26.6 ± 1.41 grams, the standard deviation 12.26 grams, and the coefficient of variation 0.45. The average weight of the thymus was 16.2 ± 0.64 grams, the standard deviation 5.49 grams, and the coefficient of variation 0.33. The coefficient of correlation of the thyroid and thymus was -0.156 with a probable error of ± 0.107 .

These calculations show a negative correlation between the weight of the thyroid and the weight of the thymus in the complete series, as Dustin and Zunz suspected. But this correlation is so low and the probable error is so large that we are hardly justified in attaching any particular significance to it. This seems the more probable since when the four cases which are of very doubtful value are omitted the correlation drops to from -0.265 to -0.156 and the probable error remains almost un-

changed. A slight negative correlation might well exist between the two organs, since the thyroid follows the scheme of general body growth and increases a little in weight during the third decade, while the thymus decreases in absolute as well as relative weight after early adolescence. But this negative correlation does not warrant the assumption of a functional relation between the two organs; a similar correlation might be expected between the thymus and any of the viscera which follow the general scheme of the growth in mass of the body as a whole.

In order to test this relation in another way I have calculated the coefficient of correlation of the thyroid and thymus in a series of twenty-five full-term newborn children. The data for this series were taken in part from the lists of cases reported by Valtorta (3) and Lomer (4) and in part from my own records. The average weight of the thyroid in this series was 3.4 ± 0.24 grams, the standard deviation 1.8 grams, and the coefficient of variation 0.53. The average thymus weight was 14.2 ± 0.90 grams, the standard deviation 6.7 grams, and the coefficient of variation 0.47. The coefficient of correlation of the thymus and thyroid was $+0.19$ with a probable error of ± 0.08 . Thus in the newborn, as in the adult, the variability of the thymus and the thyroid is very great and the correlation between the two organs is quite small. But, in contrast to the adult, the slight correlation which does exist in the newborn is a positive one.

These figures indicate that any correlation which may exist between the weights of the thyroid and the thymus is inconstant in postnatal life, and they offer little if any support to the concept of a direct functional relation between the two organs.

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- 3 VALTORTA, F. 1909 Ricerche sullo sviluppo dei visceri del feto. La individualità nel neonato. *Ann. Ostet. e Ginecol.*, T. 31, pp. 673-713.
- 4 LOMER 1889 Ueber Gewichtsbestimmung der einzelnen Organe Neugeborener. *Zeitschr. f. Geburtsh. u. Gynäkol.*, Bd. 16, S. 106-130.

Resumen por el autor, George B. Wislocki,
Johns Hopkins Medical School.

Observaciones sobre el comportamiento de la tinta china inyectada en animales durante la preñez.

Experimentos llevados a cabo durante muchos años han venido a demostrar que las partículas inertes que flotan en la circulación materna no pueden atravesar la placenta y penetrar en el feto. La explicación de este fenómeno, mediante el cual el material en suspensión no atraviesa la placenta o las membranas fetales, no ha sido hallada más que para un grupo de sustancias, esto es, los colorantes vitales. Estos colorantes, conforme Goldmann ha demostrado en el caso de la rata y ratón, son absorbidos y acumulados en el epitelio coriónico y las células de la membrana vitelina, y de este modo se previene su penetración en el feto. El autor ha inyectado gránulos de carbón suspendidos en acacia (tinta china) en una serie de conejillos de indias, conejos, gatos y perros preñados. Los animales fueron sacrificados después de unos cuantos días y los tejidos examinados. El autor ha podido observar que los gránulos de carbón se depositan en el hígado, bazo, pulmones y médula ósea de la madre. En la placenta, membranas fetales y órganos de los fetos no pudo hallar carbón, ni aún estudiándolos bajo el microscopio. La conclusión que se deriva de la repulsión de las partículas de tinta por las células de la placenta y membranas fetales es que dichas células son incapaces de absorber o fagocitar material extraño de tamaño grosero, flotante en la sangre. El límite del tamaño de las partículas que pueden absorber debe estar localizado entre el de una suspensión grosera, tal como la tinta china, y una dispersión ultramicroscópica, como el azul trypan.

Translation by José F. Nonidez
Cornell Medical College, New York

OBSERVATIONS UPON THE BEHAVIOR OF CARBON GRANULES INJECTED INTO PREGNANT ANIMALS

GEORGE B. WISLOCKI

Department of Anatomy, Johns Hopkins Medical School

It has long been known that certain cells of the body possess the power of removing foreign particulate matter from the blood-stream. Thus, when foreign particles, such as the carbon granules of india ink, are injected into the circulation of an animal, they are completely removed from the blood-stream in a remarkably short period of time. Gross and microscopic examination of the tissues of the animal reveals that the endothelial cells in certain organs have removed the ink from the circulation. The endothelial cells lining the sinusoidal channels of the liver and spleen are found heavily laden with the foreign particles. In addition to the granules of carbon which have been actually phagocytized, aggregations of the particulate matter into tiny clumps are found within the lumen of the blood sinuses. The bone-marrow in many animals is the site of a similar but subordinate process.

The question of the behavior of the cells of the placenta toward particulate matter circulating in the blood-stream has been only incompletely investigated. Recent writers on the problem of placental transmission, namely, Zuntz ('04), Kehrer ('08), and Hofbauer ('10), concur in the statement that particulate matter does not pass from the maternal into the fetal blood-stream. The explanation of the failure of suspended material to pass through the placenta or fetal membranes has not been given except for one group of substances, namely, the vital dyes. The vital dyes, which are ultramicroscopic dispersions of certain of the acid azo dyes have been rather fully investigated by Goldmann ('09). He showed that when these dyes are introduced into the blood-stream of a pregnant mouse or rat,

they stain the maternal tissues, the placenta, and the outermost fetal membrane, but fail to stain the fetus. He discovered that the reason for this apparently was that the dye-stuffs were absorbed and stored by the cells of the chorion and vitelline membrane and thereby prevented from entering the fetus.

It has, however, not been determined whether more coarsely dispersed substances than the 'vital dyes,' such as the carbon granules of india ink, are similarly phagocytized and stored by the cells of the placenta and fetal membranes or whether they are completely rejected by these cells. In the literature one finds numerous brief statements regarding the fate of coarse particulate substances injected into the blood-stream of pregnant animals. The earlier experimental work is surprisingly contradictory and but little importance can be assigned to most of it, as the observations were made on an insufficient number of animals and the methods employed were often open to criticism. Thus, Reitz ('68) described cinnabar (red sulphide of mercury) in the tissues of a rabbit fetus after injecting the mother; Caspary ('77) reported a similar result with cinnabar in a rabbit; Perls ('77) recorded the passage of cinnabar and ultramarine into the fetuses in several rabbits and dogs; Mars ('80) observed the passage of a number of emulsified substances into rabbit fetuses, and, finally, Pyle ('84) stated that he observed the passage of ultramarine into a series of rabbit fetuses.

On the other hand, Hoffmann and Langhan ('69) failed to find cinnabar in the fetuses of a rabbit which they injected; Fehling ('77) and Ahlfeld ('77) reported the failure to find india ink in the liver, kidneys, or blood of the fetuses of several rabbits, and Miropolsky ('85) obtained similar negative results with cinnabar.

Krukenberg ('88), who can be said to have undertaken the first thorough investigation of this kind, injected a suspension of barium sulphate into one series of pregnant rabbits and a non-pathogenic organism, *B. prodigiosus*, into another series. Neither particles of barium sulphate nor organisms were recoverable from the tissues of the fetuses. His experiments left little doubt that particulate materials, such as he employed, are not transmitted from mother to fetus.

Hofbauer ('10) obtained similar results after injecting colloidal silver and silicium into several pregnant animals. Neither of the substances could be found in the fetal organs.

Finally, Goldmann ('09) undertook his experiments with acid azo dyes, and showed that they, too, were not transmitted to the fetus. Goldmann's report contains the only description of the microscopic examination of the placenta and fetal membranes. In the mouse and rat the giant-cells, the chorionic ectoderm of the labyrinth, and the epithelium of the vitelline membrane were found heavily laden with granules of dye; these cellular accumulations of the dye-stuff were looked upon as evidencing the protective mechanisms of the fetus.

In the present experiments a filtered solution of india ink was used. The ink was administered intravenously to a series of pregnant animals, consisting of one dog, three cats, three rabbits, and three guinea-pigs. The amount of ink injected was regulated according to the size of the animals, the guinea-pigs receiving 1 cc., the rabbits and cats 5 cc., the dog 15 cc., on two successive days. The animals were sacrificed one or two days after the last injection.

The gross distribution of the india ink was essentially the same in all the species of animals examined. At autopsy the liver and spleen were found to be deep black and the lungs presented a grayish appearance. The bone-marrow in the rabbit was of the same color as the liver and spleen; in the guinea-pig it was not so black, while in the cat and dog its color appeared to be normal. The uterus appeared unstained. The placentae, fetal membranes, and the fetuses showed nothing to the naked eye suggesting the presence of ink particles in these tissues. The remaining organs and tissues of the animals appeared normal. The findings in gross, therefore, indicated that the injected ink granules had in whole or greater part been segregated in the liver, spleen, bone-marrow, and lungs, and that none had been deposited in the placentae, fetal membranes, or fetuses.

Microscopic examination revealed the characteristic deposition of the carbon particles in the endothelial phagocytes of the liver, spleen, and bone-marrow. Particles, in part free and in part

phagocytized, were also found, to a slight extent, in the inter-alveolar septa of the lungs. In the remaining organs and tissues of the body, with the exception of a few particles occasionally caught in a blood vessel or phagocytized within an endothelial cell, the carbon granules of the india ink were conspicuously absent.

No carbon particles could be found on examining the placentae. The chorionic epithelium, which in varying patterns is the predominating tissue in them all, showed no evidence of having absorbed particles of ink. The endothelial cells, which in the cat's and dog's placentae completely line the maternal vessels, had not the power of phagocytizing ink particles as had the endothelium of the liver, spleen, and bone-marrow. None of the ink-particles had agglutinated in either the maternal vessels of the dog's and cat's placentae, or in the corresponding sinuses of the rabbit's and guinea-pig's placentae, as they do in the sinuses of the liver and spleen. In the columnar cells of the chorion which flank the placentae of the dog and cat, known respectively as the 'green' and 'brown borders,' no carbon was visible. Nor were particles of ink discovered in the cells covering the vitelline membrane which in the rabbit and guinea-pig forms the outermost fetal membrane and faces the uterine mucosa.

The absence of particles of india ink in all these localities is surprising, since in vitally stained animals these same cells, namely, the chorionic epithelium and the epithelium of the vitelline membrane, are heavily laden with minute granules of trypan blue.

The conclusion to be drawn from the rejection of the ink particles by the cells of the placentae and fetal membranes is that they are incapable of absorbing or phagocytizing coarse, foreign particulate matter afloat in the blood-stream. The limit of the size of particles which they are capable of accepting must lie somewhere between that of a coarse suspension, such as india ink, and an ultramicroscopic dispersion, such as trypan blue. Trypan blue in turn, although absorbed by the chorionic epithelium and fetal membranes, is incapable of entering the

fetal circulation as true solutions have been shown readily to do. Trypan blue, however, may be on the border line of transmissibility, since traces of it actually enter the fetal circulation in the rabbit and guinea-pig.

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THIRTY-SEVENTH SESSION

Wistar Institute of Anatomy and Biology, Philadelphia
March 24, 25 and 26, 1921

THURSDAY, MARCH 24, 9.30 A.M.

The Thirty-seventh Session of the American Association of Anatomists was called to order by President Charles F. W. McClure, who appointed the following committees:

Committee on Nominations for 1921: Professor Ross G. Harrison, Chairman, and Professors Henry H. Donaldson and G. Carl Huber.

Auditing Committee: Professor F. T. Lewis, chairman, and Professor Stacy R. Guild.

The remaining morning session was devoted to the presentation of scientific papers.

FRIDAY, MARCH 25, 11.30 A.M. ASSOCIATION BUSINESS MEETING, President CHARLES F. W. McCLURE, presiding.

The Secretary reported that the minutes of the Thirty-sixth Session were printed in full in *The Anatomical Record*, volume 18, number 3, pages 211 to 218. On motion, seconded and carried, the minutes of the Thirty-sixth Session were approved by the Association as printed in *The Anatomical Record*.

Professor F. T. Lewis reported for the Auditing Committee as follows: The undersigned Auditing Committee has examined the accounts of Doctor Charles R. Stockard, Secretary-Treasurer of the Association of Anatomists, and finds the same to be correct with proper vouchers for expenditures and bank balance on December 29, 1920, of \$164.40.

[Signed] F. T. LEWIS,
STACY R. GUILD

The Treasurer made the following report for the year 1920:

Balance on hand January 20, 1920, when accounts were last audited	\$173.12
Receipts from dues 1920	2,521.43
Total deposits	<u>\$2,694.55</u>
Expenditures for 1920:	
Expenses Secretary-Treasurer, Washington Meeting	\$36.08
Postage and Telegrams	44.90
Printing and Stationery	160.75
Collection and exchange on drafts	3.67
Stenography, typewriting	48.75
Wistar Institute, subscriptions to Journal of Anatomy, Anatomical Record, etc	<u>2,236.00</u>
Total expenditures	<u>\$2,530.15</u>
Balance on hand	\$164.40
Balance on hand deposited in the name of the American Association of Anatomists in the Corn Exchange Bank, New York City.	

On motion the report of the Auditing Committee and the Treasurer were accepted and adopted.

The Committee on Nominations, through its Chairman, Professor H. H. Donaldson, placed before the Association the following names for members of the Executive Committee, term expiring 1924, Professors S. W. Ranson and R. J. Terry.

On motion the Secretary was instructed to cast a ballot for the election of the above named.

The Secretary presented the following names recommended by the Executive Committee for election to membership in the American Association of Anatomists:

- ABBOTT, MAUDE E., A.B., C.M., M.D., Curator of the *Medical Museum, McGill University, Montreal, Canada.*
- ALLEN, EDGAR, Ph.B., A.M., Instructor in Anatomy, Washington University School of Medicine, *4555 McKinley Avenue, St. Louis, Mo.*
- ALFORD, LELAND BARTON, A.B., M.D., Associate in Clinical Neurology, Washington University School of Medicine, *Humboldt Building, St. Louis, Mo.*
- BLAIR, VILRAY PAPIN, A.M., M.D., Associate in Clinical Surgery, Washington University School of Medicine, *Metropolitan Building, St. Louis, Mo.*
- BROOKS, BARNEY, B.S., M.D., Associate in Clinical Surgery, Washington University School of Medicine, *4918 Forest Park Boulevard, St. Louis, Mo.*

- DART, RAYMOND A., M.B., Ch.M., M.Sc., Demonstrator in Anatomy, University College, Gower St., London, W. C. 1, England. *Temporary Address: Johns Hopkins Medical School, Baltimore, Md.*
- DAVIS, WARREN B., M.D., Instructor in Anatomy, Jefferson Medical College, 135 S. 18th Street, Philadelphia, Pa.
- DE CARLO, JOHN, M.D., Instructor in Topographic and Applied Anatomy, Jefferson Medical College, 1124 Ellsworth St., Philadelphia, Pa.
- DENDY, ARTHUR, D.Sc., F.R.S., Professor of Zoology, University of London, King's College, Strand W. C., London, England.
- GARCIA, ARTURO, A.B., M.D., Professor of Anatomy, College of Medicine and Surgery, Manila, Philippine Islands.
- GRAVES, WILLIAM W., M.D., Professor of Nervous and Mental Diseases, St. Louis University School of Medicine, Metropolitan Building, St. Louis, Mo.
- GREGORY, WILLIAM KING, A.M., Ph.D., Curator of Comparative Anatomy, American Museum of Natural History, 77th Street and Central Park West, New York City.
- GEORGE, WESLEY CRITZ, A.M., Ph.D., Associate Professor of Histology and Embryology, University of North Carolina Medical School, Chapel Hill, North Carolina.
- HARTMAN, CARL G., Ph.D., Associate Professor of Zoology, University of Texas, Austin, Texas.
- HAUSMAN, LOUIS, A.B., M.D., Instructor in Psychiatry, Johns Hopkins Hospital, Baltimore, Md.
- HILL, EBEN CLAYTON, A.B., M.D., Instructor in Anatomy, Johns Hopkins Medical School, Baltimore, Md.
- HUGHSON, WALTER, S.B., M.D., Assistant in Anatomy, Johns Hopkins Medical School, Baltimore, Md.
- INOUE, MICHIO, M.D., Professor of Anatomy, Tokyo Imperial University, Tokyo, Japan.
- LEVI, GIUSEPPE, M.D., Professor of Anatomy, University of Torino, Torino, Italy.
- MEAKER, SAMUEL R., A.B., M.D., Teaching Fellow, Department of Anatomy, Harvard Medical School, Boston, Mass.
- NANAGAS, JUAN CANCIA, M.D., Assistant Professor of Anatomy, College of Medicine and Surgery, Manila, Philippine Islands. (*Temporary address—Dept. of Anatomy, Johns Hopkins Medical School, Baltimore.*)
- NICHOLAS, JOHN SPANGLER, B.S., M.S., University Fellow in Zoology, Osborn Zoological Laboratory, Yale University, New Haven, Conn.
- NONIDEZ, JOSÉ F., Sc.M., Sc.D., Instructor in Anatomy, Cornell University Medical College, 1st Avenue and 28th Street, New York City.
- PATTEN, BRADLEY MERRILL, A.M., Ph.D., Assistant Professor of Histology and Embryology, School of Medicine, Western Reserve University, 1353 East 9th Street, Cleveland, Ohio.
- PERKINS, ORMAN C., A.M., Assistant Professor of Anatomy, Long Island College Hospital, 335 Henry St., Brooklyn, New York.
- SACHS, ERNEST, A.B., M.D., Professor of Clinical and Neurological Surgery, Washington University School of Medicine, 97 Arundel Place, St. Louis, Mo.
- SHELLSHEAR, JOSEPH LEXDEN, M.B., Ch.M., Demonstrator of Anatomy, University College, Gower St., London, W. C. 1, England. (*Present address—Dept. of Anatomy, Johns Hopkins Medical School, Baltimore.*)

- SMITH, DAVID T., A.B., Medical Student, *Johns Hopkins Medical School, Baltimore, Md.*
- STONE, LEON STANSFIELD, Ph.B., Assistant in Anatomy, *Medical College, Yale University, New Haven, Conn.*
- STONE, ROBERT S., B.A., Assistant in Anatomy, *Peking Union Medical College, Peking, China.*
- STOPFORD, JOHN SEBASTIAN B., M.D., Professor of Anatomy, *University of Manchester, Manchester, England.*
- SWINGLE, W. W., Ph.D., Instructor in Zoology, *Yale University, New Haven, Conn.*
- VAN DER HORST, C. J., Ph.D., *Zoologisch Laboratorium, Pl. Muidergracht 34, Amsterdam, Holland.*
- WALMSLEY, THOMAS, M.D., Professor of Anatomy, *Queens University of Belfast, Belfast, Ireland.*
- WOOLLARD, HERBERT T., M.D., Demonstrator of Anatomy, *University College, Gower St., London, W. C. 1, England.*

On motion, the Secretary was instructed to cast a ballot for all the candidates proposed by the Executive Committee. Carried.

The Secretary then announced the following names as dropped from the list of members on account of non-payment of dues for the past two years:

- DR. A. E. AMSBAUGH, *Letterman Hospital, San Francisco.*
- DR. ROBERT S. GUTSELL, *University of Minnesota.*
- DR. JOHN A. KITTLESON, *University of Nebraska, Omaha.*
- DR. WILLIAM E. MCCORMACK, *University of Louisville.*
- DR. GEORGE WALKER, *Johns Hopkins Medical School.*

It was announced that the Executive Committee had voted to hold the next annual meeting at Yale University, New Haven, Conn., during the last week of December, 1921. The Federation of Biological Societies holds its meeting in New Haven at the same time.

A Committee on Editorship of Journals was elected by the Executive Committee following the last meeting: C. R. Stockard, Chairman; C. M. Jackson, G. L. Streeter, R. J. Terry and C. R. Bardeen.

The Committee on Editorship of Journals reported as follows:

PROPOSED ORGANIZATION OF A JOURNAL COMMITTEE
OF THE AMERICAN ASSOCIATION OF ANATOMISTS
AND ITS DUTIES.

1. There shall be organized a Journal Committee composed of five members elected by the Association.

2. The Committee shall be established in 1921, as follows: Ten members of the Association shall be nominated by the Executive Committee of the Association. Additional nominations may be made from the floor. Members of the Advisory Board of The Wistar Institute shall not be eligible for nomination in 1921. Election shall be by ballot. The five receiving the largest number of ballots shall constitute the Committee. In case of a tie, the choice of those thus tying shall be by lot. Of the five thus chosen, the one receiving the greatest number of votes shall serve for five years, the next for four years, the next for three years, the next for two years and the next for one year.

3. At the annual meeting in 1922, and subsequent years, one member shall be elected to serve for five years. Members are eligible for reelection. At least two nominations shall be made by the Executive Committee of the Association and other nominations may be made from the floor. The election shall be by ballot.

4. In case of resignation of a member of the committee, the place of the member thus resigning may be filled temporarily by appointment by the Committee itself until the next annual meeting of the society. At this meeting the place vacated shall be filled by nomination and ballot as outlined in Section 3, except that the election shall be for the balance of the unfulfilled term.

5. The duties of the Committee shall be:

(a) The selection of a responsible Editor for The American Journal of Anatomy and of a responsible Editor for The Anatomical Record.

(b) The appointment of Associate Editors, if such are desirable, shall be made by the committee in consultation with the responsible Editor concerned.

(c) In conjunction with the responsible editors of the two journals and with the Director of The Wistar Institute, the outlining of the broad, general policies in the conduct of the journals.

(d) The making of an annual report to the Association concerning journal policies.

The report of the Committee was formally adopted by the Association.

The Executive Committee in conformance with Section 2 of the report later nominated ten members of the Association as candidates for membership on the Journal Committee of five. One other name was added by nomination from the floor.

Members of the Association then cast their ballots for five of these names with the following result:

C. R. STOCKARD was elected to serve for five years;
G. L. STREETER to serve for four years;
C. M. JACKSON to serve for three years;
C. R. BARDEEN to serve for two years; and
F. T. LEWIS to serve for one year.

The terms of service were arranged according to Sec. 2 of the report.

A proposed change in the constitution affecting the length of term for the several officers of the Association was voted upon and defeated.

The president announced the nomination by the Executive Committee of Charles R. Stockard as the representative of the Association in the Division of Medical Sciences of the National Research Council.

On motion the nomination was accepted and the nominee elected to represent the Association.

The business session then adjourned.

SATURDAY, MARCH 26. A SHORT BUSINESS SESSION FOLLOWED THE MORNING SCIENTIFIC SESSION.

The President announced that he had appointed Professor Ross G. Harrison as a delegate to represent the Association at The Second International Eugenics Congress which meets in New York City, September 22-28, 1921.

The Journal Committee reported the selection of Charles R. Stockard as Managing Editor of *The American Journal of Anatomy*, and John Lewis Bremer as Managing Editor of *The Anatomical Record*.

The place on the Journal Committee made vacant by the selection of Dr. Stockard as a Managing Editor was filled until the next annual meeting by the appointment of Dr. Ross G. Harrison.

President McClure was requested to present the greetings and best wishes of the Association to Professor George A. Piersol who was ill at his home in Philadelphia and unable to attend the meetings.

Professor S. W. Ranson introduced the following resolution:

RESOLVED: That the Association express its sincere thanks and appreciation to The Wistar Institute of Anatomy and Biology and to the local committee for the exceptional facilities and accommodations which have served to make the meeting a marked success, and for the cordial hospitality that has been so generously extended to all in attendance.

Unanimously voted.

On motion the Session adjourned.

CHARLES R. STOCKARD,

Secretary of the Thirty-Seventh Session of the
American Association of Anatomists

ABSTRACTS

1. *On the development of the ameloblasts of the molars of the albino rat, with special reference to the enamel-free areas.* WILLIAM H. F. ADDISON and J. L. APPLETON, JR., University of Pennsylvania.

The crowns of the molar teeth in the albino rat, as in other rodents, have enamel-free areas on the cusps. These areas are always destitute of enamel from the time of first formation of the crown. The development of the enamel organ in these teeth is interesting, because of the differences which the functional and non-functional ameloblasts exhibit at different stages. The structure of the young enamel organ is similar to that of ordinary mammalian teeth. Up to the time of first formation of enamel and dentine (seen at first day after birth in first molar), all the cells of the ameloblastic layer are similar in size and structure. Soon after enamel formation has begun, however, differences appear in the formative and non-formative ameloblasts. Both classes of cells continue to grow for a time, but the non-formative cells grow more slowly and never attain the height of the formative cells. By the time the formative cells have attained their greatest height, the non-formative cells have begun to diminish in size. This diminution in size continues until the tooth erupts. At sixteen days the functional ameloblasts of the first molar measure 21μ and over in length and the non-formative cells about 7μ . The developmental history of the enamel organ shows that this condition of enamel-free areas is secondary to the condition where enamel covers the entire crown. This again is evidence that persistently growing teeth (in which enamel is always to some degree lacking) have been derived from rooted teeth.

2. *The oestrous cycle in the mouse.* EDGAR ALLEN (introduced by R. J. Terry), Washington University School of Medicine.

Using Stockard and Papanicolaou's method of diagnosing oestrus by the cell contents of the vaginal fluid, I have studied the cycle in the mouse. The changes are similar to those in rats reported by Long-Evans ('20). The average duration of the cycle is from four to six days. External signs are a poor criterion of 'heat,' occurring in less than 60 per cent of cases, where oestrus was shown to be present by cell changes. During oestrus there is little uterine discharge, the changes in the vaginal contents being due primarily to an alternate infiltration into, and absence of leucocytes from, the vaginal epithelium, and a periodic formation and destruction of the granular and horny layers. There is no bleeding into the lumen of the uterine cornua, nor any extravasation of red blood corpuscles into the stroma, but only a slight destruction of the mucosa by leucocytosis. There is a hypersecretion of the uterine glands during oestrus resulting in distention of the cornua, effected by a constriction of the cervix; the vagina being usually dry. Goblet cells are abundant in the epithelium of the oviducts. In some mice ovulation is spontaneous at every oestrus, so that

the ovaries are chiefly masses of corpora lutea. In others, where regular cycles have been recorded, no recent corpora lutea are present, while there are many atretic follicles which can be grouped to correspond to the recorded 'heat' periods. Consequently, all mice do not ovulate spontaneously during oestrus, and some ovulate only sporadically.

3. *Ovogenesis in the sexually mature mouse.* EDGAR ALLEN (introduced by R. J. Terry), Washington University School of Medicine.

The question of the formation of definitive ova (those ovulated during sexual maturity) is still an open one. According to different investigators, they have been derived from, (1) the primordial ova; (2) from an embryonic proliferation of the germinal epithelium; (3) from a similar proliferation between birth and sexual maturity, and, (4) in a few instances by the continuance of ovogenesis from the germinal epithelium during the sex life of the individual. Kingery derives the definitive ova, in the mouse, from the germinal epithelium during a period from three to forty days after birth, stating that it does not continue after that time. At sexual maturity cyclic changes appear in the genital organs. The period preceding oestrous is the period of augmented growth. In ovaries of several mice killed at this time I have found a complete series of stages in ovogenesis from the germinal epithelium identical to those figures for earlier stages by Kingery. Therefore, ovogenesis is not complete at birth or before puberty, but continues on into sexually mature life, and the germinal epithelium of the ovary is homologous to that of the testis tubules.

4. *On monozygotic human twins.* LESLIE B. AREY. Northwestern University Medical School.

Two specimens of early monozygotic human twins, each case unique of its kind, are presented. The first comprises twin embryos, each 12.3 mm. long, contained within a single amnion and chorion; except for some shrinkage of the entire specimen, the embryos are normal. Each possesses its own umbilical cord and yolk-stalk; the latter are inserted separately on a common yolk-sac. This furnishes for the first time direct proof of the origin of human identical twins from a single ovum. The second specimen is of normal monochorionic twin embryos, each lying within its own amnion. One member of the pair (11.5 mm. in length) has a normal yolk-stalk and sac (4.5 x 6 mm.); the other individual (12 mm. long) lacks these structures completely, as gross and microscopic examination prove. Certain inferences are suggested: 1) Human monozygotic twins do not result from the separation of blastomeres or blastomere clusters at the earliest stages of cleavage, but from a later fission of the inner cell mass. 2) Nevertheless, the human ovum appears to be rather rigid or determinate in its development; at least, in this case one embryo received all the yolk-sac formative cells. 3) The yolk-sac is not necessary for growth or differentiation; in fact, the twin individual lacking a yolk-sac is slightly the larger, while the correlation of menstrual age and body size coincides with the norm. 4) The yolk-sac and -stalk are not prerequisite to vasculogenesis; here was performed, as perfectly as ever may be expected, a natural experiment of ablation which demonstrates the independence of the embryo from such angioblastic ingrowths.

5. *The motor cortex of the brain of the sheep.* CHARLES BAGLEY, JR., Psychiatric Clinic, Johns Hopkins University.

A demonstration covering the histological study of the cortex of the brain of the sheep was given at the 1916 session of the American Association of Anatomists. The present communication is limited to the motor area of the brain of the sheep.

The motor cortex, as outlined in the early studies on the basis of histological structure alone, has been studied through means of electrical stimulation and some important differences brought out. The chief difference is the extension forward of the motor area to the most anterior pole of the brain and the elimination of an area of large pyramidal cells posterolateral to the principal motor area in the superior frontal convolution. Six areas can be satisfactorily outlined, the first three in the superior frontal convolution. Stimulation of the first two areas in the posterior extremity of the gyrus produces response in the limbs of the same and the opposite sides, while stimulation of the third area gives conjugate movement of the head and eyes to the opposite side. Area 4 lies between the olfactory sulcus and the outer prolongation of the coronal sulcus, and when stimulated gives contraction of the face muscles, more marked in the lower lip of the opposite side. Area 5 is just to the outer side of the coronal sulcus in the mesial portion of the middle frontal convolution; stimulation of this area gives response in the face muscles of the same side. The cortex giving response to electrical stimulation has been extirpated in three parts and the material stained by the Marchi method. The first extirpation area was the entire superior frontal convolution and included areas 1, 2, and 3. The second extirpation area included stimulation area 4, namely, that for the control of the opposite face muscles, while the third included area 5. Degeneration is clearly demonstrated in the fibers of the pyramidal tract in all of the extirpation specimens; these fibers cannot be traced beyond the upper cervical cord.

6. *The morphologic index.* R. BENNETT BEAN, University of Virginia.

A new index has been devised whereby any measurable character of a race, a group, a type, or an individual may be represented by a single numerical symbol. This symbol is plus or minus, depending upon whether it is above or below the world average of the character. The morphologic index is actually the percentage above or below the average. This may be illustrated by contrasting a few morphologic indices of the Scotch and Negrito.

Morphologic indices

CHARACTER	SCOTCH	APPROXIMATE WORLD AVERAGE	NEGrito
		cm.	
Stature	+10.30	165	-6.07
Nasal index	-18.75	80	+18.75
Cephalic index	-2.50	80	+3.75
Skeletal index	+0.96	52	-2.88

The nasal index differentiates the Scotch and Negritos more than do the other three factors, and the stature is the next best differentiator.

The actual stature may be obtained from the morphologic index by multiplying the world average by the morphologic index and adding the result to or subtracting it from the world average. The actual stature of the Scotch is 175 cm. and of the Negritos is 148 cm. The nasal index, cephalic index, etc., may be obtained in like manner.

We may take the morphologic index of any group of Scotchmen or Negritos, or of any type within the group, or of any individual, and compare them in many ways.

The morphologic index gives a numerical symbol that is simple, exact and convenient. It enables one to see at a glance the extent of variation from the world average, and thus to evaluate any factor, to determine its usefulness as a differentiator of race, group, type, or individual. It may also obviate the use of such terms as dolichocephalic, mesocephalic, brachycephalic; leptorrhine, mesorrhine, platyrrhine; leptoprosopic, mesoprosopic, euryprosopic; macroskele, mesatiskele, brachyskele.

7. *The value of sections of the body in teaching surgical and medical anatomy.*

CHARLES W. BONNEY, Jefferson Medical College.

The object of this paper is not to describe the preparation of the sections of the body nor to discuss their value in teaching descriptive anatomy. The former is thoroughly understood by modern anatomists, the latter in use in numerous American Medical Colleges. It is desired to emphasize the value of sections in teaching applied, surgical and medical anatomy. For that purpose they have been employed at the Daniel Baugh Institute of Anatomy of the Jefferson Medical College for the last seven years. A brief description of the methods used together with illustrative examples will be presented. Lantern slides will be used.

8. *The middle period in the development of the cloaca in chick embryos.* EDWARD A. BOYDEN, Harvard Medical School.

This abstract deals with a portion of a comprehensive study embracing the development of the hindgut and associated regions in four species of bird embryos. Attention is called at this time to only a few points of interest: to the expansion of the allantois within the body cavity to form a pars coelomica of that organ; to the formation of a temporary urodaeal sinus which resembles in a striking way the adult urodaeal chamber of certain snakes and lizards which functions in these animals as a dorsal bladder; and to some new facts concerning the origin and nature of the bursa of Fabricius.

Up to this time the primordium of the bursa has been usually described as a swelling in the posterior dorsal wall of the cloaca caused by the coalescence of vacuoles arising within the cloacal membrane during the fifth and sixth days of incubation (cf. Lillie, p. 317). This description gives the bursa a unique origin, setting it apart from all other derivatives of the gut tract and adding one more difficulty to the interpretation of an organ which has been a bone of contention among anatomists since its discovery in 1604 by Fabricius, who ascribed to it the function of a receptaculum seminis. As a result of a quantitative study of

chick embryos between the fourth and fifth days of incubation, designed originally to explain the nature of accessory diverticula found between the rectum and anal plate, it has been possible to demonstrate that the primordium of the bursa appears a day earlier than hithert supposed and in the form of a caudally directed diverticulum whose cavity at first is in direct continuity with the cavity of the cloaca. In its later development the bursa unites with the protodaeum in a manner that closely resembles the union of the proctodaeum with the anal sacs in turtle embryos. And there are other resemblances between these two organs which superficially suggest an homology. Whether this proves to be true or not it is probable that the bursa should be classed with those derivatives of the gut tract, likewise arising as diverticula, whose functions are now obscure, but whose histogenesis suggests lymphoid degeneration.

9. *The early morphogenesis of the cerebral hemispheres of Amblystoma.* H. S. BURR, Yale University, School of Medicine.

A study of the early morphology of the cerebral hemispheres was suggested by some interesting results obtained in an experimental study of regeneration in the forebrain of *Amblystoma*. Evagination of the lateral wall of the neural tube occurs in the region of the confluence of the S. limitans and the S. diencephalicus ventralis and involves that portion of the lateral wall which intervenes between it and the lamina terminalis anteriorly. In this region lies the anlage of the olfactory bulb and the adjacent secondary olfactory centers, the latter crossed by the S. diencephalicus medius. The point of most rapid growth lies at the anterior end of the S. ventralis and seems to involve a short portion of the neural tube which lies between it and the lamina terminalis. Relatively little of the wall of the forebrain is evaginated, the definitive hemisphere growing very largely through the rapid increase in the number of cells forming the outpouching. This growth occurs principally at the anterior pole, producing rapid anterior elongation of the hemisphere. Growth in the dorsal and posterior region is much slower though greater than in the ventral region where growth is largely produced through the thickening of the walls. The successive development of fiber-tract systems shows that many nuclei develop in the hemispheres as a result of the ingrowths of the fiber tracts into the region involved. The nucleus medianus septi particularly shows evidence of growth after the appearance of the portion of the median forebrain tract which runs to it. From previous experimental work it can be stated that the primordia of the gray nuclei will develop to some extent without the ingrowth of tract systems, but the complete size development occurs only after nervous connections are established.

10. *The growth of the external dimensions of the human body in the fetal period and its expression by empirical formulae.* (Lantern.) L. A. CALKINS (introduced by R. E. Scammon), Department of Obstetrics and Gynaecology, University of Minnesota.

A graphic and mathematical analysis of measurements of seventy external dimensions of the body of upward of 400 preserved fetuses 2.3 to 54 cm. in length. The uncorrected curves of these dimensions (plotted against body length) are of three types: a) straight lines; b) curves approaching straight lines, but deflected upward toward their terminations; c) curves approaching straight lines but

deflected downward toward their terminations. Many larger specimens were injected. An extensive study of this technique shows that this causes the upward trend in most *b* curves, and that when eliminated they become straight lines. All downward deflected curves are of head dimensions affected by birth-molding. Observations on comparatively unmolded heads (breech extractions and caesarian sections, prove that these also are really straight. Only five curves (median-line measurements of upper parts of the body probably affected by head flexion) are not straight after elimination of artifacts.

External bodily dimensions plotted against body length (being, in general, straight lines) are expressed by the empirical formula, $Y = aX \pm b$ (*Y*, dimension; *X*, body length; *a* and *b*, constants). The constant *b* is positive for the head, zero for the thorax, and negative for the abdomen, pelvis and extremities.

It may be concluded: 1) The relative growth rates of the external body dimensions are established in the third month and remain unchanged until birth. 2) The growth of the external body dimensions in the fetal period follows the law of developmental direction.

11. *Studies on the dynamics of histogenesis. IV. The biomechanical interaction of differential growth as a factor in the origin of bone.* EBEN J. CAREY, Marquette School of Medicine.

Increased density or condensation is the chief physical property which characterizes osseous tissue. Is this quality self-engendered in the tissue involved or is it the mechanical resultant of the interaction of differential growth? In a former communication by the writer evidence was presented in support of the idea that embryonic bone is the immediate consequence of induced stresses and not the product of an anticipated function. Many workers on bone development consider that stresses are induced in, and strains manifested by the skeleton only after birth when the body weight is sustained. If such is the case, why does bone form in the upper extremity of man at all? Experiments which have been devised to disprove the mechanical origin of bone have not carried their point. The fact that the blastemocartilaginous skeleton is an area of accelerated longitudinal growth and that the surrounding soft parts are retarded in longitudinal growth has been entirely overlooked.

Two areas in syncytial continuity and manifesting differential growth, as the skeletal and soft areas in the limb, exert an interaction. The zone of accelerated growth drags along the one of retarded growth, the latter in turn tends to slow down the speed or deflect the course of the former. This active interplay between growing parts tends to a dynamic equilibrium, but as long as one growing part is dominant and the other subdominant, growth and the resultant interaction and differentiation continue. The effect of interaction in the experimental production of double monsters is excellently treated in a recent monograph by Stockard (*Am. Jour. Anat.*, 1921, vol. 28, pp. 115-277).

The stresses induced in the origin of bone are the result of growth and resistances. The accelerated growing blastemochondrogenous skeleton meets the following resistances: 1) Opposed growth of contiguous skeletal segments; 2) weight of related soft parts; 3) reactive elasticity of traction of the soft parts retarded in growth; 4) active muscular pull. It is imperative, therefore, that, 1) *Growth* and 2) *Resistances* to growth be understood by the embryologist before

he can appreciate the importance of each factor. Both are active and formative during development, both are absolutely necessary to the realization of form and neither processes can be looked upon as more important in development than the other.

12. V. *The law of density of a growing tissue: On the progressive augmentation of femoral density as the resistances to the growth of the femur increase.* EBEN J. CAREY, Marquette School of Medicine.

With the rapid increase of limb weight, and with increase of opposition to growth at the ends of the femur, together with the resistances manifested by muscular reaction, the density of the femur increases progressively. This increase in density is concomitant with the relative decrease in femoral volume as the growth of the limb advances. In an 18-mm. embryo the volume of the femur constitutes one-third of the entire limb, whereas its density is 0.33. In a 20-mm. embryo femoral volume is one-fourth that of the limb and its density is 0.37, whereas in the 50-mm. embryo the volume of the femur is one-seventh and the density is 0.43. The density of the femur in a 200-mm. embryo is 1.6 and the volume is one-sixteenth that of the limb.

THE LAW OF DENSITY OF A GROWING TISSUE: *The density of a growing tissue is directly proportional to the resistances (pressure) encountered during growth.*

13. VI. *The law of relative volume of a growing tissue: On the relative decrease of femoral volume as the resistances to the growth of the femur increase.* EBEN J. CAREY, Marquette School of Medicine.

The various steps in the increase of skeletal density, from the blastemal to the cartilage period, and, secondly, from the cartilage to the osseous period, in skeletal condensation, are considered simultaneously with those changes, extrinsic to the zone of femoral formation. During the early stages of development, the weight of the entire hind limb is supported by the femur's acting like a cantilever beam. The weight of the limb increases rapidly. In an 18-mm. pig embryo the femur constitutes one-third of the volume of the limb and supports a weight of 0.013 grams. In a 20-mm. embryo the femur constitutes one-fourth the volume of the limb and supports a weight of 0.018 gram, whereas at the 50-mm. stage of the developing embryo, the femur constitutes one-seventh of the volume of the limb and supports a weight of 0.25 gram. Later at the 20-cm. stage the femur constitutes only one-sixteenth of the volume of the limb, but it supports the greatly increased weight of 30 grams. In addition to sustaining the above weight, the femur is opposed in growth by the accelerated growth centers located proximally and distally. Finally, as development continues, the resistance presented to longitudinal femoral growth by the contracting musculature and elastically reacting soft parts are opposing factors to be considered as extrinsic pressure limiting the relative volume of the femur to the thigh, as growth continues.

THE LAW OF RELATIVE VOLUME OF A GROWING TISSUE: *The relative volume of a growing tissue is inversely as the resistances (pressure) which it bears.*

14. VII. *On the torsion of the developing femur.* EBEN J. CAREY, Marquette School of Medicine.

That the femur undergoes a torsion during development has not been previously observed. This twist is objectively evident by observing the ventral aspect of a closely graded series of developing femora from the time the femur is approximately 3 mm. in length until it is 30 mm. in length. In a 3-mm. femur the head is in a direct line with a plane projected through the mid-ventrodorsal aspect of the shaft cutting through the center of the articular surface for the patella. This is objectively evident in a 3-mm. femur. With the next marked advance in development in a 9-mm. femur we find the head displaced mesiad. This torsion of the femur through an arc of 90° is in reality due to the torsion and development of the greater trochanter influenced by the traction of the attached gluteal muscles. This twist of the femur corresponds in time with the beginning and ending of limb rotation and with the period of greatest growth, differentiation, and activity of the thigh musculature.

15. VIII. *The law of joint formation: Bio-mechanical interaction of differential growth as a factor in the origin of joints.* EBEN J. CAREY, Marquette School of Medicine.

The blastemal skeleton of the acetabulum and the femur is apparently continuous. The femur, tibia, and fibula, and the foot plate progressively appear in the order named by the direct extension of the accelerated proliferation of the blastemal skeleton, comparable to the progressive caudal formation of metameres in the chick embryo. The first radical change from the apparently continuous to the segmental skeleton is seen in an embryo, 16 mm. long, by the appearance of a faintly curved line of compressed nuclei in the region of the future hip-joint. In an embryo 18 mm. in length another compression line is detected in the region of the future knee-joint.

1. By the continued opposition to growth between the contiguous centers of the segmental blastemal skeleton, mechanical compression occurs revealing the location of the future joint cavities.

2. The contour of the opposed surfaces constituting a joint is dependent on the intensity of the force of growth, per square millimeter of cross-section, of growing segments opposed in action, together with the force of muscular pull. That segment will possess the ball of a ball-and-socket joint which possesses the greater force of interstitial growth, longitudinally per square millimeter of cross-section.

3. Joints, therefore, are not the cause of skeletal segmentation, they themselves are the mechanical resultants of compression of prior centers of accelerated growth, opposing each other in action in the segmental blastemochondrogenous skeleton.

4. THE LAW OF JOINT FORMATION: *The contour of the opposed surfaces forming a joint is dependent upon the intensity of the force of interstitial growth, per square millimeter of cross-section, of the segments forming a joint and upon the resistances to the growth of each skeletal segment.*

16. IX. *The law of direction of myogenesis: The bio-mechanical interaction of differential growth as a factor in the origin of muscular tissue.* EBEN J. CAREY, Marquette School of Medicine.

Is the physical property which characterizes the initiation of muscular differentiation, namely, specific elongation of the nuclei and spongioplasm, caused by a factor intrinsic or extrinsic to the zone of myogenesis? The writer has presented evidence of direct observation which proves that the latter and not the former is the case. In other words, muscle is the resultant of the tension, pulling out or traction to which a syncytial mass of mesenchyme is intermittently but progressively subjected by a related region of cells accelerated in growth.

It was shown formerly that the dominant zone of accelerated growth in the intestine is the epithelial tube. By expansion of the epithelial tube in spiral growth the surrounding mesenchyme was drawn out in tension resulting in helical muscular differentiation. In the limb the zone of accelerated growth is the central segmental skeletal core. This draws out by traction the surrounding mesenchyme resulting in skeletal muscular differentiation. The zone of accelerated growth in the cardiac area is the progressive increase in the whirling volume of the blood. This draws out the surrounding mesenchyme in tension corresponding to the direction of the vortex of blood resulting in spiral muscular differentiation. The detail proofs for these assertions will soon be published.

THE LAW OF DIRECTION OF MYOGENESIS: *The elongation of a developing muscle is in the direction of the accelerated growth of an extrinsic dominant zone which draws out in tension the mesenchyme forming the muscle.*

17. *The development of the aster in the artificial parthenogenesis of the sand-dollar egg.* ROBERT CHAMBERS, Cornell University Medical College.

No noticeable changes occur in the cytoplasm or the nucleus of the eggs until long (half an hour or more) after both the butyric-acid and the hypertonic-solution treatments. The visible phenomenon peculiar to the parthenogenetically induced egg consists in the manner in which a fluid substance begins to separate out of the egg cytoplasm, preparatory to the formation of the preliminary single aster. In the sperm-fertilized egg radiations appear immediately about the sperm head, and the accumulation of the fluid substance is from the very start through the agency of the ray-like channels of the growing aster.

An optimum parthenogenetic treatment causes vacuoles to appear which fuse to form a central clear area about which radiations develop until an aster is formed corresponding exactly with the fully developed sperm aster of a normally inseminated egg. From now on the procedure is similar to that occurring in a sperm fertilized egg.

Over-treatment causes the appearance of many vacuoles scattered throughout the egg resulting in multiple asters. Under-treatment may result in the formation of a single aster which, however, periodically disappears and reappears as a single aster. A successful treatment not only causes a separating out of a liquid from the egg cytoplasm, but also induces a polarity within the resulting clear area to enable it to form two centers about which an amphiaster may develop.

18. *The reaction of living cells in the tad-pole's tail toward injected starch granules.*

ELLIOT R. CLARK and ELEANOR LINTON CLARK, University of Missouri.

Small quantities of starch (corn-starch and arrow root) were injected into the transparent tails of frog larvae and the region of injection studied in the living during the subsequent hours and days.

Uncooked starch, boiled starch, and starch cooked just to the point of gelatinization were tried. The larvae were fixed in iodine at different periods of time after the injection.

Toward the uncooked starch granules the response was similar to that displayed toward foreign bodies, such as carbon and carmine. Leucocytes approached the starch grains and engulfed them and the starch remained inside the leucocytes indefinitely (over a month).

The boiled starch grains disintegrated within the first half hour after injection and after an hour no stain was obtained after treatment with iodine. Wandering cells moved toward the injection site.

In the case of the semi-cooked starch, near-by wandering cells moved very rapidly toward the injected material and within twenty minutes leucocytes began to emigrate from neighboring blood-vessels in very large numbers. Within an hour the starch grains were all inside of leucocytes. The diapedesis of leucocytes continued for six hours or more. Leucocytes staining blue with iodine were demonstrated from three to four hours after the injection. The further stages in digestion were not followed since the characteristic reaction of dextrin or of glycogen was not obtained and our microchemical tests for sugar, injected into the tail fins, were unsuccessful.

Starch cooked to the point of gelatinization proved to be a most powerful chemotactic agent for leucocytes. The other tissue cells showed no response toward injected starch.

19. *Cyclic changes in the ovaries and uterus of the sow, and their relation to the mechanism of implantation of the embryos.* GEORGE W. CORNER, Johns Hopkins Medical School.

The author has completed a detailed study of the follicles, corpora lutea, and uteri of a large series of pregnant and nonpregnant animals killed at known stages throughout the oestrous cycle. The cycle averages twenty-one days in length. Ovulation is found to occur during oestrus; the corpora lutea complete their formation about the seventh day, and remain in full development from the seventh to the fifteenth day, thus surviving just long enough to cover the period of attachment of the embryos. If no embryos are present the corpora lutea degenerate about the fifteenth day.

A few days before and during oestrus the uterine epithelium is in a state similar to that described by Stockard and Papanicolaou and by Long and Evans in the small rodents; but during the growth period of the corpus luteum the uterus undergoes histological changes culminating, from the eighth to the tenth day, in a state of enhanced epithelial activity. At this time the embryos, when present, are still unattached and are being shifted into position for implantation. From the tenth to the fifteenth day (the period of implantation), further elaborate changes take place by which the epithelium is brought to a state characteristic of early pregnancy in the implantation stage. If no embryos are present the same changes occur, but subside after the fifteenth day.

These results indicate that there is a correlation between the state of the corpus luteum and that of the uterus by which the uterus is prepared, after each ovulation, to receive embryos. A detailed and illustrated monograph will appear in the publication of the Carnegie Institution.

20. *Digestion of different proteins by the mesenchyme and its derivatives in the tadpole.* (Lantern.) VERA DANCHAKOFF, Columbia University.

Though well known to exist within the multicellular organism the phagocytic digestive activity of the mesenchyme has not been much studied. Little is as yet known regarding the amount of digestive work accomplished in the organism by the mesenchyme, if given opportunity. Neither is the extent known to which this activity becomes a factor in the resistance which a multicellular organism offers to the growth of heterogeneous tissues even of such a great proliferative capacity, as, for example, the tumors.

The adult splenic mesenchyme of the fowl, as shown by me last year, is capable of ingesting and digesting, one by one, cells of a mammalian proliferating tumor. The mesenchyme and its derivatives, in the form of small wandering cells, in various tadpoles, will be shown to possess the power of digesting various proteins. The mesenchymal tissue within the tail of different tadpoles can be fed on finely particulated fibrin, edestin, coagulated albumen, and lecithin, the particles being of the size of a small fraction to a few diameters of a mesenchymal cell. The response to the sudden appearance of a large quantity of injected material is rapid from the part of the mesenchymal and wandering cells. Four to six hours after injection a great number of mesenchymal cells and of cells of the small lymphocyte type are found around and within the injected mass; about twenty-four hours after the injection all but the largest particles are ingested, and after three to four days no trace of the injected material is found.

The results of these experiments illustrate the great digestive capacity inherent in the mesenchymal and small lymphocyte cells of the amphibia during the tadpole stage. These cells can most effectively take care of comparatively huge masses of injected particulated protein, and like physiologically balanced unicellular organisms, if given opportunity, successfully perform their own digestive activity.

21. *Further morphological evidence for the digestive capacity of adult splenic mesenchyme in the fowl.* VERA DANCHAKOFF and S. M. SEIDLIN, Columbia University.

A new morphological evidence for the digestive capacity of the mesenchyme was brought forward by Danchakoff last year. The splenic reticular cells of the adult fowl were shown to be capable of surrounding and digesting the living cells of an actively proliferating mammalian tumor (the Ehrlich sarcoma). The encircling of the tumor cells by the mesenchyme, followed by digestion, as observed in Danchakoff's experiments, is the result of the immediate encounter of two living tissues. A further study of the digestive capacity of the mesenchyme was required in order to ascertain whether the living tumor cells were treated by the mesenchymal cells in the same manner as dead particles of mammalian protein would. Small particles of catgut were intimately mixed with mash of adult splenic tissue and grafts of this tissue made on the allantois of seven days chick embryos.

The study of the grafts after five days' growth has shown the particles of catgut partly digested, partly attacked by the mesenchyme. Mesenchymal cells isolated and in the form of more or less huge plasmodia surround the catgut particles, the latter showing distinct indentations, which in outline often correspond to mesenchymal cells. The mesenchymal plasmodia close to the partly digested catgut contain vacuoles. The process of digestion where the catgut particles are small is very similar to that exercised by the mesenchyme against the cells of the Ehrlich sarcoma. The splenic mesenchymal cells of the adult fowl seem to be capable of exercising phagocytic and digestive activity regardless of whether this activity is directed against sterilized particles of heterogeneous dead tissue or against living heterogeneous tumor cells of certain physico-chemical constitution.

22. *A new interpretation of the morphology of the nervous system.* RAYMOND A. DART and JOSEPH L. SHELLSHEAR (introduced by R. J. Terry), University of London.

His ('68) promulgated his principle of ectodermal origin of neural tissue. Balfour and others extended this hypothesis to postulate a neural tube origin of all neuroblasts. Beard, Platt, Landacre, and others have shown that a large proportion of the cranial ganglionic elements arises in the ectoderm lateral to the medullary area from certain areas called 'placodes.' Observations by J. P. Hill, Elliot Smith, and the authors have demonstrated a similar peripheral but entodermal origin in placodes for the visceral elements in the VII, IX, and X cranial nerves throughout Vertebrata. A radical revision of current conceptions is therefore necessitated.

The 'placodal' principle of a peripheral origin for all neuroblasts of the peripheral nervous system is of general application. The only point of agreement between students of the ontogeny and phylogeny of the sympathetic system is of the first appearance of the so-called 'primary Anlagen' peripherally and in inextricable relationship with the mesodermal structures supplied thereby. That the sympathetic system develops independently of the neural tube was shown by Weber in 1851. A mesodermal origin of these neuroblasts must therefore be postulated and is demonstrable.

But these are not the only mesodermal neuroblasts. Concurrently with the differentiation of the somite from indifferent cells into the various 'supporting tissues' of the body there arise from similar 'indifferent cells' of the primitive somite the neuroblasts for the innervation of these tissues. The somite, then, has this property in common with definitive placodes previously described by various authors; it gives rise to a) neuroblasts and b) supporting tissue. A rational phylogenetic and ontogenetic explanation is provided in this way for the proprioceptive senses. The anterior horn cells of the neural tube must, however, be appreciated as primarily 'extraneural.' The neural tube itself is considered as a series of bilaterally segmented placodes. The data entail further a revision of the conception of neurobiotaxis as put forward by Ariens Kappers. This principle is given wider application for the interpretation of the movements of sensory neuroblasts which move away from the 'source of stimulus.' The nervous systems of Vertebrata and Invertebrata are harmonized by the 'placodal' conception, and an hypothesis is promulgated to account for the origin of the

former. Finally, the problems of segmentation and the mesoderm are deemed to be more correctly appreciated from the new point of view.

23. *Degeneration phenomena in the pelvic gland of the male Necturus.* A. B. Dawson, Loyola University School of Medicine.

Pelvic glands of males, killed during the late autumn and winter, exhibit degeneration phenomena similar in many respects to those recently described by Saguchi ('20) in the frog's pancreas under the title, 'physiological degeneration.' Although numerous cells are degenerating, the gland is secreting actively. Nucleoli are not demonstrable in the normal cells and it seems impossible to interpret the large eosinophilic central corpuscle of the 'chromocyte' as being a result of nucleolar hyperchromasy. The nucleus undergoes successive changes characteristic of Flemming's chromatolysis. Some degenerating cells escape directly into the lumen of the tubule; others, however, are sooner or later taken up by neighboring normal secreting cells. Within the normal cells the plasma of the degenerating cells is digested and absorbed rapidly. The degenerating nuclei usually become separated into several portions, either by direct fragmentation or a process of gemmation, and are ultimately eliminated, along with the secretion of the normal cell, into the lumen of the tubule. No phagocytosis was observed in connection with this degeneration and no mitosis was evident at this period of the year. These intracellular corpuscles, derived from degenerating gland cells, resemble 'nebenkerne' and have been so interpreted by many investigators working on glands. The small spherical nuclear fragments simulate basophilic secretion granules.

Pelvic glands from animals killed in July present a very different picture. The lumina of the tubules are reduced to a minimum and mitotic figures are encountered very frequently. Large phagocytes filled with disintegrated cells are numerous.

24. *The growth of the brain and the spinal cord in the human fetus and its expression by empirical formulae.* HALBERT L. DUNN (introduced by R. E. Scammon), University of Minnesota.

A quantitative study of the growth of the brain and its parts and of the spinal cord in a series of 156 human fetuses ranging from 4 to 56 cm. in crown-heel length. The growth of the central nervous system in the fetal period follows, in a general way, the growth of the body, and its increase in weight and volume may be expressed by formulae similar in type to that expressing growth in body weight. Further analysis shows that three distinct subdivisions or varieties of this general type of growth may be recognized in the central nervous system. These are, 1) cerebral growth, which shows a slow but steady increase prior to five and one-half or six months (ca. 30 cm. CH) and a constant and more rapid growth from that time to birth; 2) brain-stem and cord growth, which proceeds comparatively rapidly previous to the sixth fetal month and comparatively slowly thereafter, and, 3) cerebellar growth, which is characterized by a slow rate of growth prior to the seventh fetal month and by an extremely rapid rate of increase thereafter.

25. *Hematological and respiratory conditions in the larval stages of the lungless amphibians, Batrachoseps attenuates and Aneides lugubris.* V. E. EMMEL, University of California.

In attempting to correlate the remarkable occurrence of non-nucleated erythrocytes in *Batrachoseps attenuates* (Am. Jour. Anat., vol. 16, p. 180; Anat. Rec., vol. 18, p. 232) with physiological factors, a comparative study was undertaken between this animal and *Aneides lugubris*. Both amphibians are lungless, have similar environments, but differ widely hematologically. It became necessary to carry the investigation into the larval stages. We were fortunate in securing one set of eggs for each species. A number of larval animals were removed from the egg before hatching and blood preparations made. In the larval *Aneides* all erythrocytes were nucleated, but in the larval *Batrachoseps*, on the contrary, non-nucleated erythrocytes were almost as abundant as in the adult.

It thus becomes evident that whatever physiological factors may be responsible for the marked hematological differences in these two species, they must be already operative before hatching. The larval respiratory gill structures show striking differences. *Aneides* has a very broad, three-lobed, leaf-like gill membrane, permeated by a complex capillary network. *Batrachoseps* has a simple, slender, three-fingered gill structure, traversed by a single vascular loop for each finger-like process. In *Aneides* the blood corpuscles pass through the gill capillaries in a single file, whereas in *Batrachoseps* the blood is carried through each vascular loop as a column of corpuscles in the manner of a small arteriole. In contrast to *Aneides*, therefore, we have in the larval *Batrachoseps* a respiratory mechanism relatively deficient in capillary exposure of the blood. This condition is apparently compensated for by the increased oxidation efficiency of the thin non-nucleated erythrocytic discs, thus furnishing a phylogenetic precursor of the erythrocytic efficiency finally attained in mammals.

(Further studies on the physiology of reproduction include abstracts 26 to 34.)

26. *Proportion of ova producing full-term young in the rat.* JOSEPH A. LONG and HERBERT M. EVANS, University of California.

We are beginning to appreciate the widespread and customary occurrence of departures from perfect functioning of the mammalian reproductive apparatus—departures which reduce fertility. These may be due to fault with ovary, tube, or uterus. They are occurring continually. During the last three years we have recorded the number of young in 625 litters of the rat. The average lies between six and seven. During this period of time fifty animals were sacrificed within one day after ovulation and at least one oviduct and ovary cut serially. In all instances the eggs from this ovulation were encountered in the tube and were enumerated. An average was found of 4.8 eggs in each oviduct or 9.6 eggs per ovulation. Other material in which the eggs could not be enumerated with reliability, but in which the corpora lutea of a single ovulation could be counted, was studied. This showed that five corpora per ovary or ten per ovulation represented the average. The animals from which data were secured concerning the number of eggs or corpora were treated in every respect as to food, cage space, etc., identically with the animals in which the number of litter young was

recorded. They were also in many cases litter mates of such animals. Evidently, then, under these conditions nine or ten ova are represented by only six or seven offspring carried to term.

27. *On the production of the condition of 'pseudopregnancy' by infertile coitus or mechanical stimulation of the cervical canal in the rat.* JOSEPH A. LONG and HERBERT M. EVANS, University of California.

We have previously shown that the advent of the next oestrus is delayed when the rat is allowed to mate with a vasectomized male or when the cervical canal is stimulated by the momentary insertion of a small glass rod. This pause, which we have proved to result from delayed ovulation, may be due either to some sort of direct repression of follicular growth or to a continuance of life of the corpora lutea which in the case of cattle have apparently been shown to hold off follicular growth and oestrus. The corpora lutea in these cases come to resemble those of pregnancy. As we have previously explained, we are to understand this remarkable response as a contrivance to insure implantation. The fact that deciduoma are difficult to produce during normal oestrous cycles, but can be produced after cervical stimulation, is in strict harmony with the idea that changes are thereby provoked which facilitate implantation. We may suppose something has occurred to 'activate' the corpora lutea. The corpora are affected through humoral paths, since these phenomena all occur with the transplanted ovary. But nervous pathways are probably concerned in initiating the change, for the products of abrasion of the cervical mucosa do not themselves cause these changes (Freyer; see below). The designation 'pseudopregnancy' is justified on further grounds than because of the prolongation of life span of the corpora lutea. Most striking is a change in the character of the vaginal epithelial mucosa. In pregnancy the vaginal mucosa becomes a high stratified epithelium, but with its surface cells columnar instead of squamous in type. Furthermore there ensues a characteristic vacuolization of its middle cell layers, a phenomenon beginning about the tenth day of gestation and reaching its greatest expression on the sixteenth day. These changes are inaugurated in the vaginal mucosa ten or more days after mechanical stimulation of the cervical canal.

28. *On the cause of the effects produced by stimulation of the cervical canal in the rat.* M. G. FREYER (introduced by H. M. Evans), University of California.

The delay in the appearance of the next oestrus and the condition of so-called pseudopregnancy produced by mechanical stimulation of the cervical canal in the rat has been shown by Long and Evans to take place in animals in which ovarian transplantation has recently been carried out. We can, hence, not refer this effect to the nervous connections of the ovary itself. It seemed possible that the slight injury to the cervical epithelium might lead to hormonal products which when absorbed and reaching the circulation thus affect the ovary directly or indirectly by means of some other endocrine gland.

At the suggestion of Doctors Evans and Long, six careful experiments were carried out in order to test this point. Epithelial scrapings were made from the lower portions of the cervical canal of six animals which were in the pro-oestrous period or at the transition between pro-oestrus and oestrus. This material, obtained under aseptic precautions, was immediately injected into the perito-

neal cavity of six other animals which happened to be at the same stage of the oestrous cycle. The succeeding oestrous cycles in the recipient animals were of normal duration. None of the characteristic effects of cervical stimulation were obtained. It would hence appear that the initial part of this mechanism is actually mediated by nerve impulses which, however, produce humoral changes so that the corpora lutea of recently transplanted ovaries, which can only be reached by the blood stream, are in some way invigorated and continued in function.

29. A characteristic histology of the vaginal mucosa during lactation. JOSEPH A. LONG and HERBERT M. EVANS, University of California.

During lactation the vaginal smear in the rat resembles closely the picture found during the dioestrous interval of the normal oestrous cycle, i.e., it consists of polymorphonuclear leucocytes and a variable content of irregularly sized epithelial cells. Nevertheless, the histology of the vaginal mucosa at this time differs widely from that found in the dioestrous pause. We have previously established the fact that ovulation does not occur during lactation. Ovulation is always heralded by characteristic changes in the structure of the vaginal mucosa and also in the vaginal smear. In both pregnancy and lactation ovarian function is manifested by actively secreting corpora lutea which in turn may be viewed as repressing all follicular growth and activity. We have shown in the preceding section that a characteristic vaginal histology occurs throughout gestation. It is also a fact that during gestation the vaginal smear resembles that of the normal dioestrous pause. Similarly during lactation characteristic changes occur in the vaginal mucosal histology without changes in the smear. The epithelium in one respect resembles that found in pregnancy in that it possesses a surface layer of cylindrical cells. But the gravid vaginal mucosa is high, that of lactation low. While on the second day of suckling this mucous membrane may consist of four or five cell layers, by the fourth day more than three layers are seldom encountered, and on the sixteenth day, when lactation may be assumed to be at its height, most of the mucosa consists of but two cell layers, the superficial of which is constituted by cubical or low cylindrical elements. The strict dependence of this characteristic epithelium upon the performance of the mammary glands, which divert and limit ovarian function to the corpora lutea, is illustrated in the most striking way when the young are removed. Within forty-eight hours after removal of the young the low columnar mucosa of lactation gives place to a high, stratified squamous epithelium.

30. On the production of deciduomata during lactation. JOSEPH A. LONG and HERBERT M. EVANS, University of California.

Our preliminary experiments seemed to indicate that deciduoma were not easily produced by the contact of foreign bodies with the uterine mucosa during lactation. We were consequently under the impression that the rarity of conception during lactation might be referable to an unfavorable implantation reaction in some way associated with lactation. We have continued our operations upon the uterus during lactation. Typical deciduomata can be produced when the procedure is carried out at any time after the fourth day of lactation and the animal sacrificed one week after the operation. It is consequently neces-

sary to refer the well-known comparative immunity from a second gestation which characterizes the early period of lactation in all animals, to the lack of ovarian changes associated with both heat and ovulation, not to difficulties in implantation of ova. The existence of a vigorous deciduoma reaction during lactation when uterine atrophy normally occurs would appear to establish conclusively the relation of this response to the existence of functional corpora lutea, for in all conditions in which functional corpora are present the response can be elicited.

31. Cyclic changes in the mammary gland of the rat associated with the oestrous cycle. MONROE SUTTER (introduced by H. M. Evans), University of California.

The exact mechanism responsible for the assumption of function on the part of the mammary gland has received a considerable amount of attention during the last few years. Although an indirect nervous connection between mammae and uterus exists (influence of suckling on uterine contractions), it has been generally assumed that the development of the mammary apparatus is due to hormonal influences. As is well known, these hormones have been variously supposed to come from corpus luteum, placenta, or foetus. I have been encouraged by Doctors Evans and Long to study the changes which may be observed in the mammary glands of virgin female rats at various steps in the oestrous cycle. The study of sections was eventually abandoned and gross mounts were made of spreads of the entire glands which had been stained and cleared.

The following conditions have been detected: Toward the end of the pro-oestrous stage (stage 0 of Long and Evans) the mammary tree exhibits long, slender branches which have a few almost naked twigs projecting from them. Close inspection reveals that there are many minute bud-like processes on the twigs and on the main branches at infrequent intervals. In the next stage, oestrus (stage 1 of Long and Evans), when cornified epithelial cells are found in the vaginal smear, undoubted evidence occurs of pronounced growth in the mammary tree. The small buds on the mammary twigs have sprouted out to varying degrees and new ones have appeared. Instead of appearing generally smooth and naked, the branches and twigs are irregular and covered with numerous projecting buds. The size and shape of the branches vary greatly from branch to branch and in a given branch. This great variability appears to be one of the most marked characteristics of rapid growth. By the time leucocytes have appeared in the vaginal smear, evidences of further growth in the mammary tree can be seen in the increasing complexity of the secondary branches. By this time we know that ovulation has normally occurred and young corpora lutea have been formed. The end branchings of the mammary tree often form transparent bulb-like projections which vary greatly in shape and size. This complexity of the tree and some slower growth of it undoubtedly continue until near the next pro-oestrous stage when, possibly due to degeneration of the corpora lutea, regression occurs.

There is thus a regular cycle of growth changes imposed upon the mammary ducts, and although these are undoubtedly accelerated and are maintained by the corpora lutea, they may be detected and are quite marked before the corpora are formed.

32. *On the rapid maturation of the ovary by transplantation of the youthful gonad to adults.* JOSEPH A. LONG and HERBERT M. EVANS, University of California.

In order to determine whether we could produce an experimental precocity in the development of the remainder of the reproductive system, we attempted to transplant adult ovaries into young animals. As a matter of fact, an exchange of ovaries was carried out between immature animals from twenty to thirty days of age and adults between five and six months of age. The adult grafts succumbed, but in every instance the immature ovaries were vascularized and grew rapidly, although these also in some instances did not continue to function. It is, however, remarkable that in all instances at least one set of Graafian follicles and corpora lutea were produced by the infantile ovaries in adult hosts. Furthermore, these changes took place in from six to eight days and brought on typical oestrus of the adult host as seen by changes in the vaginal smear, behavior, etc.

It is apparent that endocrine influences of the adult tissues are responsible for provoking this sudden maturation of the sex gland, which normally occurs from one to two months later.

33. *The method of opening of the vagina in the rat.* K. O. HALDEMAN (introduced by H. M. Evans), University of California.

At birth the lumen of the vagina extends caudal to within 1.2 mm. of the external surface of the body. The structure closing the vagina consists of a solid, branching core of stratified squamous epithelium surrounded by compact connective tissue. This condition persists until, at about the age of thirty to forty days, several centers of cornification appear in this epithelial core and vesicles containing desquamated cornified material and leucocytes are formed. The vesicles enlarge and coalesce so as to form a lumen through the epithelial core. The first external sign of impending opening is a turgescence and wrinkling of the future lips of the vagina. Occasionally a median cord extends dorso-ventrally across the vaginal orifice for several days after opening. Frequently a plug of cornified material protrudes from the opening soon after it is established. Sections through the vaginae prior to their opening in animals older than thirty days showed large masses of cornified material, non-cornified cells, and leucocytes in the lumen near its distal end. In some cases small areas of the vaginal mucosa were covered with cornified epithelium. Five cases were studied to determine whether or not ovulation had occurred, and in no instance was this a fact. These isolated patches of epithelial cornification must not be confused with the complete cornified transformation of the vaginal mucosa accompanying oestrus.

34. *On the association of continued cornification of the vaginal mucosa with the presence of large vesicles in the ovary and the absence of corpus formation.* HERBERT M. EVANS and JOSEPH A. LONG, University of California.

It has already been shown that in the normal oestrous cycle of the rat cornification changes in the vaginal mucosa are associated with the enlargement and maturation of follicles and that these changes cease at about the time of ovulation. Normally the cornified stage lasts about thirty hours.

As a rare anomaly (seven cases in about 800 rats) cornification of the vaginal mucosa may be greatly prolonged; instances of 2, 3, 5, 7, 11, 11, and even 21 days

have been observed. In one case in which cornification had persisted for five days and in two cases of eleven days the animals were tested and oestrus found to be still present. All of the seven rats were killed while this phenomenon was still in progress, and the ovaries examined in serial section. The most striking thing about them was the presence of large, fluid-filled vesicles, many of these possessing a thick, apparently healthy granulosa layer which together with the basement membrane is invaginated at many points by blood-vessels and containing what appeared to be normal eggs. Others were clearly undergoing degeneration, leading to the formation of large, thin-walled vesicles devoid of ova. In addition, the ovaries were notable by reason of the absence of normal healthy corpora lutea, those present being apparently in process of degeneration—quite markedly so in the one case of twenty-one days.

We have observed similar long cornified stages in the vaginal smears of two cases in which the ovaries were transplanted to the rectus muscle and in which also the ovarian findings resembled the above. This fact would appear to support convincingly the idea that these ovarian changes produce their effects on the vagina through humoral rather than nervous pathways.

(Experiments on the endocrine relations of the ovary in the rat include abstracts 35 to 38.)

35. *The effect of thyroid feeding on the oestrous cycle of the rat.* HERBERT M. EVANS and JOSEPH A. LONG, University of California.

Thyroid obtained daily from freshly slaughtered beeyes was fed in doses varying from $\frac{1}{4}$ gram to an entire half gland. The rats used for feeding as also those for controls were selected from a large stock because they exhibited approximately regular four-day cycles.

In all cases thyroid feeding was accompanied by an increased consumption of food, but decrease in body weight. On the one hand, when the doses were larger ($\frac{1}{4}$ to $\frac{1}{2}$ gland) loss in body weight was pronounced and some animals succumbed, the cycle being greatly lengthened or inhibited altogether. On the other hand, when the doses varied from $\frac{1}{4}$ to $1\frac{1}{2}$ grams daily, amounts also sufficient to produce loss of weight with increased consumption of food, the oestrous cycles were usually not greatly disturbed. There consequently do not appear to be specific effects of thyroid substance on the oestrous cycle.

36. *The effect of thyroidectomy on the oestrous cycle of the rat.* HERBERT M. EVANS and JOSEPH A. LONG, University of California.

Both thyroids were removed from three groups of rats which lived a long post-operative life: thirty-one adults, seventeen young rats 37 to 54 days of age, and eleven suckling ones. In all cases there was no doubt but that by far the largest part of the thyroid was excised, and in the youngest rats the operation was performed under binocular microscopes. The mortality from the operation is low. In the case of the adults the operation was usually followed by a pause in the oestrous cycles of 6 to 27 days, but in turn succeeded by normal oestrous cycles, about twenty of which were observed.

The operations on both the young and suckling animals influenced appreciably neither the time of maturity nor the lengths of oestrous cycles. Several of the second group after reaching an age of several months were autopsied and

found to possess what appeared to be lobes of regenerated thyroid tissue in many cases almost of the size of normal glands. Sections found these to be thyroids which had regenerated in spite of the effort which had been taken to secure complete ablation.

37. *The effect of feeding the anterior lobe of the hypophysis on the oestrous cycle of the rat.* HERBERT M. EVANS and JOSEPH A. LONG, University of California.

Four sets of experiments were carried on, in two of which fresh glands were fed and in two dried hypophysis from Armour & Co. and from Parke-Davis & Co. In all cases the feeding was begun at weaning, on the twenty-first to twenty-third day, litter mates being used as controls. Daily observations were made to determine the opening of the vagina and cyclical changes in the vaginal smear. A total of fifty-five rats was used for the experiments and fifty-four for controls.

The anterior lobes were dissected from the glands of freshly slaughtered cattle and were ground, weighed, and fed within six hours of slaughtering. A half gram was given each rat, which had been isolated in a clean metal box where it could be seen that the total amount given was consumed, after which the animal was returned to its cage and given ordinary food. In one set the controls were not fed differently from their mates except for the hypophysis; but in the other set the controls were given in addition $\frac{1}{2}$ gram of raw liver daily to offset the possible nutritive value of the fresh hypophysis. Each rat was weighed at intervals of four days. In both sets the hypophysis-fed animals and controls showed neither significant differences in growth nor in the age of maturity and lengths of subsequent oestrous cycles. In the case of ten adult rats the total food intake was limited to 6 to 10 grams of the fresh anterior lobe and rolled barley. Their oestrous cycles (ten to twenty of which were observed) were not sensibly altered.

Similar tests were conducted with the dried commercial substance, except that no controls were given fresh liver. But for the fact that large doses could not be given without producing intestinal disturbances, the results were not substantially different from those given above.

38. *The effect of the anterior lobe administered intraperitoneally upon growth, maturity, and oestrous cycles of the rat.* HERBERT M. EVANS and JOSEPH A. LONG, University of California.

The anterior lobes were dissected from fresh glands, were immersed five minutes in 30 per cent alcohol, rinsed thoroughly in sterile Locke's solution, triturated with a small amount of sand, and centrifuged for about half an hour, care being taken to carry out all manipulations aseptically. The supernatant fluid from centrifuging was injected into the peritoneal cavity in amounts from $\frac{1}{8}$ to 1 cc., according to the age of the rat, the first dose being given at an age of about fourteen days. At the beginning a similarly obtained fluid substance from liver was given some controls, but soon discontinued because of its toxic effect. Every animal was weighed at intervals of five days, beginning with the twentieth day of age. To date daily observations have been carried to the eightieth day. The subjoined table shows a greater rate of growth of the experimental animals as compared with their controls, a disparity which is increasing.

At the same time the effect of the anterior lobe has been to repress sexual development by delaying sexual maturity and lengthening the oestrous cycles, in some cases oestrus being entirely inhibited.

In the case of five adult rats with previously regular four-day cycles, doses of 1 to 2 cc. of the anterior lobe fluid substance caused an immediate cessation of the four-day rhythm, the smaller doses permitting oestrus to recur at longer intervals, the larger inhibiting it altogether. These results are in marked contrast to the lack of effect produced by oral administration of the anterior hypophysis. As far as the influence on sex function is concerned, they are in marked contrast to prevalent opinion.

AGE	38 EXPERIMENTAL ANIMALS	38 LITTER MATE CONTROLS
<i>days</i>	<i>grams</i>	<i>grams</i>
14	20.2	19.02
20	31.6	33.14
25	48.6	46.2
30	61.7	60.0
35	80.6	70.7
40	95.6	86.2
45	117.6	109.0
50	140.8	126.1
55	159.5	139.25
60	177.0	153.3
65	197.2	165.6
70	214.5	173.7
75	227.8	183.5

39. *The digestion and assimilation of fatty food as determined by the aid of the dark-field microscope, and a fat-soluble dye (American sudan).* SIMON H. GAGE, Cornell University.

The findings on the above reported at the last meeting of the Association have been repeatedly verified on people of various ages and on animals of widely different species. That is, with a dark-field microscope one can determine by the number of particles (chylomicrons) present: *a*) whether the fat taken with the food is being digested and absorbed; *b*) the time required for the process; *c*) the comparative digestibility of a given fat by different individuals and different species of animals; *d*) the comparative digestibility of different fats by the same individual or animal.

In the further study of the subject it has been found not only possible to determine the appearance, increase, diminution, and disappearance of the fat particles (chylomicrons) in the blood or chyle by the dark-field microscope, but with the naked eye it has been easy to follow the digested fat from the intestines to the lacteals, to the lymph nodes and to the cisterna chyli, and through the thoracic duct to the blood-vessels, and in the blood-vessels to all parts of the body. This was made possible by the use of a fat-soluble dye (American sudan), which when once dissolved by the fat, sticks so tight to it that it never lets go through all the processes of digestion, although they may involve splitting the fats into fatty acids and glycerin or even the formation of soaps and their absorption and resynthesis by the intestinal epithelium. The color serves as a label, so to speak,

and enables one to follow it in all its wanderings, and to see where it is finally deposited when assimilated.

Contrary to the general assumption that the fat is placed in temporary storage when it disappears from the blood, and is only very slowly and after considerable time finally deposited in the permanent fat reservoirs or adipose tissue, it was found that the fat was very quickly deposited in the adipose tissue of the entire body, but especially and most markedly in the adipose tissue of the omentum, mesenteries, and kidneys. The pink-stained fat is abundantly and easily recovered from the chyle, the blood and the adipose tissue thus leaving no doubt as to the nature of the pink substance.

40. *Cinematomicrography of serial sections.* W. F. SCHREIBER, STACY R. GUILD, and L. G. HERRMANN, University of Michigan.

By combining photomicrographic and cinematographic methods a film has been produced on which are pictures at a low magnification of all the serial sections of an embryo, with the individual pictures so oriented with reference to each other that, when projected onto a screen by the usual moving-picture apparatus, the images overlap in much the same way that the individual wax plates used in making a model are overlapped. Whereas the successive pictures of an ordinary film gave temporal impressions, the attempt here is to give spatial impressions. It is hoped that the method will be useful as an aid in the teaching of embryology to large groups of students, especially as a supplement to the study of serial sections by the individual members of the group. The projection of the film available at the present time will constitute the major part of the presentation of this paper.

41. *The nervous system as a factor in the resistance of albino rats to parathyroidectomy.* FREDERICK S. HAMMETT (introduced by H. H. Donaldson), The Wistar Institute of Anatomy and Biology.

Studies made on the susceptibility of albino rats to acute parathyroid tetany resulting in death showed that animals which had been gentled by petting and handling were less frequently affected by removal of the parathyroids than were rats lacking this treatment. Three hundred and four rats were operated. In one group the parathyroids alone were removed, in another, the entire thyroid apparatus, and in a third the thyroid apparatus was removed in two stages, at an interval of two weeks. About 13 per cent of the gentled rats died in acute tetany after these procedures, while about 78 per cent of the not gentled rats died within forty-eight hours after operation. These results are taken to indicate that the gentling induces a condition in the nervous system such that the demand of the organism for the parathyroid secretion is lessened to the point where the rat survives though the secretion is lacking. Since the condition of high neuromuscular tension present in the rats not gentled implies a heightened metabolism of that phase of activity concerned with muscle tone, it is possible that in these rats there is thus produced a greater amount of some toxic by-product than in those gentled, and that removal of the parathyroids also removes the mechanism for the destruction or neutralization of this toxic compound and the animals consequently succumb to the excess of the hypothetical compounds so formed.

42. *An adaptation of the fire-assay method for the determination of gold and silver in animal tissues.* SAMUEL HANSON (introduced by H. M. Evans), University of California.

Methods hitherto employed in quantitative determination of gold and silver in animal tissues have not been entirely advantageous. The titration method of Voigt for the estimation of silver is inconvenient and its accuracy uncertain. The electrolytic method of Caldwell and Leavell is complicated and time-consuming. The well-known fire-assay method may be adapted to determine very small quantities of gold and silver in animal tissues with a high degree of accuracy. The tissue for estimation is dried and pulverized. Two grams of the powdered tissue is transferred to a glazed paper and thoroughly mixed with 60 grams of silver-tested litharge, 20 grams of sodium carbonate, and 15 grams of silica. The mixture is transferred to a clay crucible and covered with 10 grams of sodium carbonate. The charge is fused in the muffle at a high temperature until no suspended droplets of lead are seen. The stage is usually reached in thirty minutes. The fused material is next poured into a conical iron mold, the lead settling on the bottom of the mold, while the fused material, or slag, collects at the top. If the fusion has been properly carried out, the slag is transparent and free from particles of lead or carbon. The slag is removed and the lead hammered into the form of a cube with blunted corners. Such a lead button should weigh between 25 and 30 grams and is placed in a red-hot bone-ash cupel in the gas or electric furnace and the cupellation continued at a temperature sufficiently high to prevent heavy fumes. The cupellation may be regarded as completed when the residue suddenly loses its brightness and appears as a small bead. The bead is weighed on the assay balance to 0.01 of a milligram. After weighing the bead, the silver, if present, is dissolved and the bead reweighed. The latter weight, of course, represents the quantity of gold present, if both gold and silver are present, while the difference between the two weights corresponds to the amount of silver.

43. *On the rapidity of absorption of colloidal gold from the peritoneal cavity.*

SAMUEL HANSON (introduced by H. M. Evans), University of California.

The phenomena of absorption of dialyzable substances from the peritoneal cavity have been extensively investigated. Phenolsulphonephthalein, for example, is absorbed from the peritoneal cavity at a known rate, evidently chiefly by way of the blood capillaries, and the mechanism of its absorption can probably be satisfactorily explained by assuming that the physical processes of osmosis and filtration are operative. In the case of the absorption of colloids and suspensoids, however, the situation is different. The experimental work done with this class of substances, with the exception of the recent paper by Cunningham and Shipley, is almost exclusively qualitative. The absorption of colloidal gold furnishes an excellent opportunity to obtain quantitative data in this field, for gold may be estimated in tissues with high accuracy (see above), and its colloidal solution made according to the method of Paal is stable and largely physiologically inert. Solutions estimated to contain 1 per cent metallic gold in physiological saline were used. Injections were made into the peritoneal cavity of rats, 1 mgm. of metallic gold per 10 grams of body weight being given. After various intervals the animals were sacrificed and the

amounts of gold found in the liver determined by the fire-assay method given above. The rapidity of absorption of the gold as determined by its deposition in the liver is remarkable, 8 per cent of the amount injected being found at the end of the first hour and 22 per cent at the end of two hours. According to Dandy and Rowntree, about 50 per cent of phenolsulphonephthalein injected intraperitoneally is absorbed within one hour. This substance diffuses readily through animal membranes and its smallest particles are probably represented by the molecular dimension; the size of the gold particles is in contrast very many fold greater, yet they traverse the peritoneal boundary at a rate at least one-sixth as rapid.

44. *The development of the balancer in Amblystoma.* ROSS G. HARRISON, Yale University.

As shown by Bell in *Diemyctylus*, the development of the balancer is determined by a patch of differentiated ectoderm overlying the mandibular region. When this ectoderm is transplanted to other regions of the embryo in *Amblystoma punctatum*, even as early as the medullary-plate stage, a normally constituted, though somewhat smaller, balancer develops. If it is replaced by ectoderm from the trunk, the front of the head, or from the gill region, no balancer develops. Removal of the mandibular mesoderm does not affect the development of the balancer, if the ectoderm is healed back in place, nor does the removal of the ganglion crest (experiment of L. S. Stone), though cells from the latter lie directly under the base of the outgrowing organ and normally probably provide its mesodermal core. *Amblystoma tigrinum* lacks balancers. If, however, proper ectoderm of *A. punctatum* is transplanted to the former species, a normal balancer with mesenchyme and blood circulation develops. The reciprocal operation apparently suppresses the balancer, though only one experiment has given this result. Owing to faulty placement of the graft in others, regeneration from the host occurred. The peculiar membrane which supports the balancer develops in the strange as well as in the normal location. Its staining qualities and the imbedding of its base in mesenchyme might lead one to regard it as a dermal bone, as Latta has done. However, it is never formed except beneath the specific balancer ectoderm, and the evidence favors its interpretation as a basement membrane.

45. *Amitosis in ciliated cells.* FRANK HELVESTINE, JR. (introduced by H. E. Jordan), University of Virginia.

In 1898 v. Lenhossek and Henneguy independently expressed the opinion that the basal bodies found in ciliated cells are derivatives of the centrosome. The corollary of this hypothesis, namely, that on account of the preemption of the centrosome in the formation of basal granules, ciliated cells must necessarily proliferate by amitosis, was later expressed by Jordan ('13), and he supported this conclusion by data derived from a comparative study of the ciliated epithelium in the ductili efferentes and epididymes of a number of vertebrates.

Saguchi ('17) confirms Jordan's results as regards vertebrates, but states that in invertebrates mitosis is the exclusive mode of division of ciliated cells. He describes cells undergoing karyokinesis as either not having cilia or as losing their cilia before the process of division takes place. Saguchi concludes from his obser-

vations that basal bodies and cilia are derived from mitochondria. His descriptions and illustrations do not bear out this conclusion, but rather add to the evidence of a centrosomal origin of the basal bodies.

In my material of the gills of the fresh-water mussel, *Cyclas*, no relationship between mitochondria and basal bodies, other than spatial, is discernible. Indirect evidence supports the view of the derivation of the basal bodies from the centrosome. In this form certain ciliated cells divide extensively only by amitosis. Saguchi admits that cells of ciliated epithelium dividing by mitosis possess no cilia at the time of division and my material confirms this observation. Such cells cannot properly be called ciliated cells and it can accordingly not accurately be said that ciliated cells divide by mitosis.

In view of the agreement between Jordan ('13) and Saguchi ('17) regarding an exclusively direct method of division in ciliated cells of vertebrates, and Saguchi's failure to find in invertebrates any cells with cilia in indirect division, and my demonstration of extensive amitotic divisions in ciliated cells of *Cyclas*, the general conclusion seems warranted that ciliated cells both in vertebrates and in invertebrates divide only by amitosis.

46. *Development of the innominate artery in the pig.* CHESTER H. HEUSER, Johns Hopkins Medical School.

In a closely graded series of injected embryos ranging in length from 3.8 mm. to 40 mm. which was prepared for a study of the transformations of the aortic arches and the related vessels, the development of the innominate artery can be followed from its primitive condition until its adult form is attained. The cephalic border of the bulbous ventral aorta in the 7-mm. embryo gives rise to the large third aortic arches and the rudimentary external carotid arteries. In embryos of 8 mm. the ventral ends of the third arches carry the external carotids so that the common carotids are already indicated. In succeeding stages beyond 8 mm. the ventral portions of the third and fourth arches are united into common trunks which gradually increase in length. This trunk is especially long on the right side and is a part of the innominate artery, but as the arch of the aorta becomes established from the left fourth arch the left common carotid becomes shifted over so that it arises also from the innominate. This condition can be seen in stages of about 21 mm. In older embryos the connections remain the same, but the innominate artery increases greatly in length, as seen in stages measuring 40 mm. or more.

47. *Extirpation and transplantation of thymi in larvae of *Rana pipiens*.* MARGARET MORRIS HOSKINS, Medical College of Virginia.

The operations were performed by E. R. Hoskins in the spring of 1919 and the report is based on a study of preserved material. Records were kept of the growth and development of the larvae and showed no effect from the experiments in this respect. The operations were of three types: complete and unilateral extirpation of thymi and transplantation of thymic tissue from one larva to another. The grafts grow well and have the appearance of normal thymic tissue. The effect of the operations on the thymi, the spleen, and on the endocrine glands has been studied from dissections and from histological preparations. When one thymus is removed there is no compensatory hypertrophy of

the remaining one, and the engrafting of thymic tissue does not affect the thymi of the host. None of the operations affects the spleen in size of appearance. The gonads, thyroids, and parathyroids also remain unchanged. In some instances the hypophyses of thymectomized larvae appear to be hypertrophied, but this is not always the case. Histologically the hypophyses of the operated animals are normal.

48. *Embryonic myeloschisis*. (Stereio-lantern.) N. WILLIAM INGALLS, School of Medicine, Western Reserve University.

The three human embryos considered naturally fall into a series of increasing teratological and pathological severity. This also applies to the embryonic adnexa. No. 83, G. L., ca. 7 mm., condition fair, chorion quite large, villi large and numerous but somewhat altered, amnion thickened, magma excessive, cord and yolk sac small, vessels indefinite. Sacral myeloschisis extending over 2.5 mm. on summit of sacral convexity, neural folds everted, prominent and sharply defined. No. 288, G. L., ca. 12 mm., condition poor, color not very good, chorion of fair size but thin, villi not well developed, hydramnios, no exocoelom, cord small, no yolk sac found, only traces of vessels. Medullary defect measures 2.5×4 mm., extending from thoracic into sacral region. Area involved is spread out on dorsum of embryo, its surface very slightly elevated, margins irregular. In No. 46 the disturbance has been much more severe. G. L. 14.5 mm., distinctly pathological, color muddy and opaque; chorion large and haemorrhagic, villi very short and scattered, hydramnios, no exocoelom, amniotic fluid slightly turbid and viscid, neither vessels nor yolk sac to be seen, cord short and markedly distended. Extensive defect involves most of cord, secondary loss of substance; marked encephalic malformation, head very small, eyes approximated, mouth gaping, nasal and palatal deficiencies. General anasarca of embryo.

49. *The effects of various types of inanition upon growth and development, with special reference to the skeleton*. C. M. JACKSON, University of Minnesota.

According to Liebig's 'law of the minimum,' as applied to animal growth by Bunge and by Osborne and Mendel for mineral and protein factors of the diet, the deficiency of any essential factor results in failure of the growth of the body as a whole, and not in the production of abnormal tissues. However, during inanition of various types there occurs a malcorrelated growth, certain organs increasing abnormally, others decreasing, with retarded or stationary body weight.

During underfeeding of young rats on a balanced diet (deficient in calories), this disproportionate growth affects practically all organs of the body, the extent varying widely in different organs; also according to age, and length and intensity of the inanition (Jackson, Stewart, Barry). Persistent skeletal growth has likewise been observed by other investigators in underfed calves, puppies, rats, and malnourished infants.

In rats on qualitatively inadequate protein diets, Osborne and Mendel found skeletal retardation proportional to that of the whole body; but more recently Mendel and Judson ('16) found persistent skeletal growth in mice. Kudo ('21) finds markedly persistent skeletal growth in rats with restricted water supply.

Absence of essential salts results in disordered or inhibited skeletal growth, in invertebrates (sea-urchin, sponges) as well as various mammals. With calcium-poor diets, the body weight may continue increasing, while the skeleton is retarded, with 'pseudorachitic osteoporosis.' True rachitis apparently depends upon a deficiency in 'fat-soluble A' vitamine. Phosphorus deficiency likewise retards skeletal development, with histological resemblance to scorbutus (which, however, is also due to vitamine deficiency).

50. *Studies of lymph nodes. II. Response of lymph nodes to irritation.* (Lantern.) THESLE T. JOB, Loyola University School of Medicine.

By injecting subcutaneously india ink in either distilled water or weak solutions of ammonium hydroxide, a condition simulating a low grade or a virulent infection may be initiated. By this method a less complicated picture is obtained but, nevertheless, just as true as when cancer cells or bacteria are injected. Thus it can be demonstrated that, in the case of ink in water, the granules are carried by phagocytes, mainly, to the first node in the drainage line. This node becomes progressively pigmented to a solid black. Then the second node in the drainage is pigmented, and so on. This being a non-irritative process, no new lymphoid tissue is formed. If ink in ammonium hydroxide be used—the ammonia being a strong irritant—the first node in the line of drainage is only partly pigmented before the second node begins to receive pigment; the lymphatic collateral circulation about the node is enhanced and an actual building up of new lymphoid tissue is begun. The significance of these results is pointed out and a practical application made.

51. *On the origin and development of the posterior lymph hearts in anuran embryos.* (Lantern.) OTTO F. KAMPMEIER, College of Medicine, University of Illinois.

The first evidence of the beginning of the posterior lymph heart on either side is manifest in 10 to 11 mm. embryos (*Bufo vulgaris*) as an accumulation of mesenchymal cells around that part of the lateral lymphatic plexus situated just lateral to the posterior vertebral vein at the level of the eleventh spinal ganglion. By gradual distention and coalescence, the vessels of the lymphatic plexus within the area of mesenchymal accumulation become transformed into a globular chamber, the posterior lymph heart. The lymph-heart anlage becomes temporarily separated from the surrounding lymphatic network, the number and position of the points of separation being relatively constant in different individuals. Two points of junction are reestablished between lymph heart and plexus, one situated on the dorsal and the other on the ventral side of the heart; later such points of entry are increased in number. The muscular coat of the lymph heart is developed from the cells of the original mesenchymal accumulation around the lymph heart plexus.

Before the efferent valve (between lymph heart and posterior vertebral vein) is formed, blood corpuscles are found in large number in the heart cavity. There is evidence that at times the embryonic posterior lymph heart itself may function as an haemopoietic center; certain it is that during its development, it, like other embryonic lymphatics, is haemophoric, that is, transports along with its lymph flow developing blood cells to the blood stream. Not only does the number of posterior lymph hearts differ among species of Anura, but it may also differ among members of the same species, and may even be different on the two sides of the same individual.

52. *Peripheral migration and distribution of medullary cells in the absence of spinal ganglia and dorsal nerve-roots in embryos of the chick.* ALBERT KUNTZ, Saint Louis University School of Medicine.

Embryos of the chick were subjected to an operative procedure at the close of the second day of incubation (forty-eight hours) by which the neural crests and the dorsal portions of the neural tube were destroyed throughout a series of successive segments. These embryos were allowed to live until the close of the fifth day of incubation. Ventral nerve-roots are present in all segments in which the motor niduli were not destroyed. Cells of medullary origin are present in these nerve-roots and along the course of their fibers. Some of these cells advance along the visceral rami and give rise to ganglia of the sympathetic trunks, others become distributed along the nerve-fibers and give rise to neurilemma. In segments in which but a small ventral portion of the neural tube remains intact, even though ventral nerve-roots but no visceral rami are present, the primordia of the sympathetic trunks are absent.

53. *Nerve terminations in the lung of the rabbit.* (Lantern.) O. LARSELL, Northwestern University.

Sensory nerve endings are found in the epithelium of the bronchial tree and its various subdivisions as far as and including the atria. These appear on anatomical grounds to consist of three types, probably receptive to different methods of stimulation. The most constant position in which sensory terminations are present is at the point of division of the various orders of branches of the bronchial tree. Motor terminations are also present, not only in the smooth muscle fibers of the bronchi and their branches, but in the pulmonary artery and its branches, including the arterioles. A few nerve fibers are also present in the tunica media of the pulmonary veins. The sensory innervation is by fairly large myelinated fibers from the vagus. The motor innervation of the bronchial musculature appears to be of the typical preganglionic and postganglionic arrangement. The preganglionic fibers terminate in characteristic pericellular networks about the cells of the intrapulmonary ganglia, and from these nerve cells processes are given off which pass to the smooth muscle bands, to terminate in relation to the unstriated muscle cells. The source of the fibers to the pulmonary vessels has not yet been determined.

54. *The growth of the organs and systems of the single comb White Leghorn chick.* HOMER B. LATIMER, University of Minnesota.

In plotting the gross weight of the eighty-six chicks upon age in days (from day of hatching to 251 days) the resulting curves show three phases; first a slow initial rise, then a rapid increase, and later a second period of slow growth. The curve for the females begins to fall below that of the males, beginning at about seventy or eighty days. The curves of the different organs and systems may be placed in four groups as follows:

1. Those which tend to parallel the growth of the body as a whole, or the muscles, ligamentous skeleton, digestive tract, lungs, heart, kidneys, suprarenals, and integument. The curves of the percentage weights of these organs on the net body weight show a more or less rapid decline, with the exception of the musculature which increases from about 25 per cent up to nearly 50 per cent of the net body weight.

2. This group is characterized by a rapid initial rise of the growth curve, followed by a slowing of the rate of growth. In this group are the brain and eyeballs and linear measurements (body length, etc.).

3. The ovary, oviduct, testes, and comb and wattles grow very slowly at first, followed by a rapid prepubertal rise, in both absolute and percentage weight.

4. The thymus and the feathers at first grow in weight a little more rapidly than the body, followed by a decrease in weight, both relative and absolute.

When the gross body weight is substituted for the age in days, the chief differences in the curves are a more precipitous rise at first and in some cases a loss of the second flatter part of the curve.

55. *The description of the coats of blood vessels contained in Galen's De anatomicis administrationibus, Lib. VII., Cap. V. A comment on its accuracy.* FREDERIC T. LEWIS, Harvard Medical School.

The description is as follows: Venae totius corporis ex peculiari una constant tunica; nam exterior membrana ipsis nonnunquam obhaerescens, ubi colligari quibusdam aut fulciri ac contegi desiderant, illuc solum accedit. Arteriae vero duae peculiare tunicae existunt: exterior sane qualis venae est: interior autem crassitie hujus fere quintupla, insuper durior, in transversas fibras dissoluta; exterior autem, quam etiam venae obtinent, rectis fibris, et quibusdam medioeriter obliquis, transversis nullis, contexta est. Interior arteriae tunica crassa duraque ceu cutem quandam interna superficie continent, telae araneorum manifesto persimilem, in magnis quidem arteriis perspicuam, quam nonnulli tertiam arteriae tunicam statuunt: quarta vero alia peculiaris ei nulla est, sed veluti quibusdam venarum, ita quoque arteriis alicubi obhaerescit et circumtenditur membrana tenuis contegens aut affirmans aut connectans ipsas vicinis particulis.

56. *The formation of vacuoles in the cells of tissue cultures owing to the lack of dextrose in the media.* MARGARET R. LEWIS. Carnegie Laboratory of Embryology.

Cells cultivated in media lacking dextrose show numerous vacuoles in twenty-four to forty-eight hours, after which degeneration rapidly ensues. When the usual amount of dextrose (0.25 per cent) is included in the media, the vacuolation, degeneration, and final death of the cells are retarded for several days. If a medium containing from 0.5 to 1 per cent dextrose is used, the cells continue in an apparently healthy condition for a much longer period of time, sometimes two or three weeks, during which vacuoles fail to appear. Ultimately, however, the cells in such cultures may exhibit vacuoles. Dextrose is an important part of the medium for tissue cultures, and it seems to be necessary in order to maintain the normal metabolism of the cells under the conditions of tissue cultures.

57. *The characteristics of the various types of cells found in tissue cultures from chick embryos.* WARREN H. LEWIS, Carnegie Laboratory of Embryology.

Each type of cell that migrates out of the explant onto the coverslip does so in a manner peculiar to its type. The blood cells and clasmotocytes pursue very irregular and uncertain paths, each cell retaining its complete independence, in that they rarely adhere together to form any sort of pattern. In marked contrast to these wandering cells are the ectodermal and endodermal cells which always migrate out in the form of a sheet or membrane, the borders of the cells

adhering to their neighbors in more or less even lines. Intermediate between these two extremes are the mesenchyme, endothelial and smooth muscle cells which form loose reticuli, in that the cells tend to adhere to one another by their processes rather than by the cell borders. The cells of each type form, however, their own peculiar characteristic pattern of reticulum. Isolated ectodermal and endodermal cells occur and still more frequently isolated mesenchyme, endothelium and smooth muscle cells. Still different are the characteristic outgrowths of long multinucleated strands from the striated muscle and the long slender nerve fibers from both the sympathetic and central nervous systems. Both the muscle strands or buds and the nerve fibers have a tendency to form anastomosing plexuses, the nervous ones being more elaborate and complicated. The various other types of cells which migrate onto the coverglass do so each in a characteristic formation of characteristic cells. These characteristics both of the individual cells and of the types of growth are retained throughout the life-history of the culture, or until marked degeneration changes take place. There is no dedifferentiation after they have grown out on the coverslip, although cell division is frequent.

58. *Smooth muscle and endothelium in tissue cultures.* WARREN H. LEWIS, Carnegie Laboratory of Embryology.

Smooth muscle from the amnion and endothelium from the sinusoids of the embryonic chick liver form a somewhat similar reticulum in the cultures. They resemble one another much more than they do the ordinary mesenchyme from the subcutaneous tissue. The smooth muscle cells have a rather thick homogeneous ectoplasm and in the living cell no indications of fibrillae are to be seen unless the cells are subjected to a sudden change. The fibrillae that have been occasionally observed under such conditions were gradually lost, the ectoplasm becoming homogeneous again. On fixation under the microscope the striae and fibrillae appear as the coagulation of the ectoplasm proceeds. The fibrillae are coagulation products of a peculiar kind of ectoplasm. They are not always parallel, but may in different parts of the spread-out cells run in groups at different angles. The peculiarity of ectoplasm which causes it to coagulate into fibrillae of varying sizes is probably a molecular thing, and it is to the latter that the contractile substance owes its peculiar properties. Our observations are in entire accord with those of Mrs. Lewis on smooth muscle.

Endothelial cells often show somewhat similar striae or fibrillae on fixation. The condition is never so marked as in smooth muscle, but it suggests that there is an unusual amount of contractile substance in endothelium which is interesting in connection with recent physiological work on the contraction of the capillaries by Dale, Krogh, Bayliss, and Hooker.

59. *Preliminary remarks upon the functional variations of the normal human mammary gland.* JOSEPH MCFARLAND, University of Pennsylvania.

In the study of cases of a morbid condition of the human mammary gland known as 'abnormal involution,' a variety of appearances were encountered that were very puzzling. The difficulty seemed to lie in uncertainty as to what was and was not to be regarded as normal, and part of the evolution and involution of the gland. Books and journals did little to help one out of the dilemma.

Text-books of histology, for the most part, describe and illustrate the structure of the mammary tissue in such manner as to lead one to suppose that, except at the time of lactation, all glands look alike.

With a view of finding out what variations in structure and appearance the normal mammary gland presents, about 200 apparently normal glands were collected, sectioned, and studied. From this work it has become evident that a number of structural types will have to be established, and it is believed that in the future it will be necessary to call the attention of the student to each of these types, in order that he shall not later be surprised and confused by finding that the structure of a gland that he is called upon to examine in the pathological or hospital laboratory does not correspond with what he has been taught and shown as a student.

60. *The influence of the lateral-line system in the development of the skeleton.* Roy L. MOODIE, University of Illinois, College of Medicine.

The study of the lateral-line canals in ancient Amphibia and primitive fishes shows a definite correlation with certain peripheral osseous elements of the head. This fact suggests that during development there may be a relationship between the formation of the canals and the initiation of osseous development.

Young catfishes, *Ameiurus nebulosus*, were cleared by the potash method and the relationship of both lateral-line canals and developing skull bones was studied. It was found that the lateral-line canals were all laid down prior to the deposition of any osseous material, but those bones which touch on the canals were the latest of the cranial elements to form. This indicates that the lateral-line canals have no influence on the initiation of osseous development, but that the canals do modify the form of the bones which they touch. The factor which causes the initiation of osseous deposition must be looked for elsewhere.

61. *On the specificity of regenerating limb-buds in adult newts.* C. V. MORRILL, Cornell University Medical College.

The present paper is a preliminary report on a series of transplantation experiments (still in progress) to test the specificity of regenerating limb-buds in the adult of the common spotted newt (*Diemyctylus*). The subdivisions of the problem are as follows: *a*) Will regenerating limb-buds retain their laterality if transplanted to opposite side of the body? *b*) Will a regenerating bud (e.g., from an anterior limb) retain its specificity if transplanted to the stump of a different kind of limb (e.g., to a posterior limb stump)? *c*) Is there any observable difference between autoplasmic and homoplasmic transplantations?

For the purposes of the experiment, regenerating buds were transplanted when about one-eighth of an inch long and just beginning to show indications of digits. In order to test out the various possibilities outlined above, anterior limb-buds were transplanted to the stumps of posterior limbs of the same and of opposite sides, and posterior limb-buds to posterior stumps of opposite sides. In some cases the buds used were taken from the same individual (autoplasmic), in other cases from a different one (homoplasmic). In this way seven different categories of experiments were made possible, though all have not yet been tested. The results in general show that in most cases the regenerating bud first loses most of its external and internal differentiation and becomes reduced

to a conical knob consisting of a layer of epithelium and an internal mass of more or less indifferent cells. There is undoubtedly some mingling of the tissues of transplant and stump. Subsequently a redifferentiation takes place; the bud lengthens out again and digits appear. In all cases so far examined the original laterality of the bud seems to be entirely lost, that is, the transplant develops into a limb corresponding in this regard to its new site. Regarding anterior and posterior specificity, the results are not uniform. As a rule, the original specificity is lost, but in one case an anterior limb-bud transplanted to the stump of a posterior limb of the same side (homopleural), but on a different individual (homoplastic), developed into an anterior limb. Aside from the case just cited, no differences between autoplasmic and homoplastic transplantations have as yet been detected, but the number of experiments is too small to warrant any conclusion. In all the types of experiments, reduplications occasionally appeared, as might be expected. Double limbs are of course the most common, but in two cases triple limbs developed. These are at present too young to interpret with certainty.

62. *Studies on the mammary gland. VIII. Gross changes in the mammary gland in the female albino rat during the period of involution.* FRANK J. MYERS AND J. A. MYERS, University of Minnesota.

Virgin animals of known age and weight were allowed to become pregnant, deliver, and nurse their young. In all cases the litters were weaned at the end of three weeks, after which the mammary glands of the mothers were collected at intervals ranging from six hours to five weeks. The glands were spread out on sheets of cork and cleaned according to the method previously described (Myers, '16). At the end of six hours the masses of glandular tissue are considerably enlarged. This enlargement which is probably due to the accumulation of milk continues through the forty-eight-hour stage. In the four-day stage the masses of glandular tissue have decreased considerably in size, while at the end of five days the glands are not more than one-half the size of those taken at forty-eight hours. In the stages taken at the end of two and three weeks the glands very closely simulate those of adult virgin animals. The most noticeable steps in involution occur during the latter part of the first week, and by the end of the second and third weeks the glands have returned approximately to their resting stage.

63. *Regulation of posture in the forelimb of *Amblystoma punctatum*.* J. S. NICHOLAS (introduced by R. G. Harrison), Yale University.

The limb-bud of the right side of the embryo has been subjected to rotations of 90°, dorsoanterior or clockwise and dorsoposterior or counterclockwise, in order to study the factors which cause rotation in transplanted limbs. Regulatory recovery occurs, being practically complete in the normal location and partially so in abnormal locations. As a rule, the limb moves through the shorter arc in recovering its normal posture, that is, the recovery process is generally in the reverse direction from the imparted rotation. Exceptions to this rule, occurring in dorsoposterior operations, show that occasionally growth factors increase the imparted 90° rotation, causing the limb to attempt recovery through the greater arc or in the same direction as the imparted rotation.

Irrespective of imparted rotation, girdle formation is in normal relation to the dorsoventral axis of the embryo, that is, it is never upside down, although it may be reversed in regard to the anteroposterior axis. The regulation of posture is primarily dependent upon the formation and size of the girdle. This is shown in heterotopic operations. The intrinsic musculature which grows back from the limb blastema to the girdle also apparently influences the recovery of the limb to its normal posture. The limb undergoes rotation as a whole. In contrast to this, the readjustment which occurs in the girdle is not by means of movements of the whole aggregate as shown by the position of portions of the pronephros which have been implanted with the limb-bud.

64. *The developmental topography of the thymus, with particular reference to the changes at birth and in the neonatal period.* (Lantern.) GUSTAVE J. NOBACK, University of Minnesota.

The thymus in the late fetus and stillborn child has a typical form and quite constant relations. Its lateral surfaces are convex and bulge against the medial surfaces of the lungs which rarely extend at all on its anterior surface. The thymus very rarely extends at all on the anterior surface of the right ventricle of the heart.

The thymus in liveborn infants has a typical form and relations which are similar to those found in young children. It is elongated and molded so that its anterior, lateral, and posterior surfaces bear the impress of all the organs with which it is in contact. Its lateral surfaces usually show marked convexities which are occupied by the lungs which pass over the anterior surface of this organ. Unlike the fetal thymus, it extends on the right ventricle. The change from the broad or fetal type of thymus to the elongate and molded type found in the liveborn and in the young infant bears a direct relation to the establishment of respiration. The organ is compressed from side to side by the medial surfaces of the expanding lungs. It is also compressed anteroposteriorly by the anterior borders of the lungs which advance medially and become much thickened early in the establishment of respiration.

65. *The postnatal growth and development of the female reproductive tract in the albino rat.* H. L. OSTERUD, University of Minnesota.

This study of the weights and microscopic structure of the ovaries, uterine tubes, uterus, and vagina of 125 rats (including thirty postpartum primiparae) shows that in adult virgin rats the tubes may attain a maximum growth of twenty-six times their birth weight, the ovaries seventy-four times, the vagina 138 times, and the uterus 197 times. All four organs exhibit four-phase growth curves. The most rapid growth occurs first during the first three weeks (lactation period) and later shortly after the sixtieth day of age. The prepubertal growth increase comes distinctly earlier in the uterus and vagina than in the ovaries. After maturity the variability especially in the uterine weight is astonishing (from 0.055 to 0.494 per cent of the body weight). The maximum uterine weight in virgins far exceeds that in postpartum primiparae after completed uterine involution. The uteri of these postpartum primiparae, however, display the tendency to a similar great growth if kept from the males for sufficient time. The extreme cases strongly suggest a parallelism between this great uterine growth

and ovarian activity, associated also with large hypophysis and perhaps thyroid. Failure of this great growth in some females is extremely difficult to account for except in cases of distinctly poor nutrition. Volumetric study of the ovaries offers no rôle in this uterine variability to the interstitial tissue. Definite correlation in the size of uterus and vagina is fairly evident, while the frequent apparent failure of the ovary to show similar correlation is probably due to its great cyclic fluctuation.

66. *Developmental competition in its relationship to the sex ratio.* GEORGE N. PAPANICOLAOU, Cornell University Medical College.

The average sex ratio in a stock of 3472 guinea pigs is 106.54 when the individuals born in all litters are considered. On comparing the ratios from different-size litters great discrepancies are found. In litters of one the sex ratio is 112.58; in litters of two, 112.07; in litters of three, 97.95; in litters of four, 108.73, and in litters of five, 141.02. These variations may be explained on the following principles derived from a careful analysis of the developmental conditions in guinea pigs:

1. There is a competition between developing germ-cells and embryos in the ovary and the uterus.
2. In the competition males have some advantage over the females.
3. Competition is higher in the larger litters (by a litter is meant the number of codeveloping germ-cells and embryos).
4. In litters consisting of embryos of the same sex competition is higher than in mixed litters.
5. The competition is stronger among females than among males.

In agreement with these statements there is a higher percentage of complete elimination of large litters, consisting chiefly of females than of any other large litters. This elimination produces the high sex ratio for the litters of four and five. The originally large litters in which the subsequent elimination is partial result in births of one and two. Elimination being more severe on the female members causes the production of a higher sex ratio than occurs among individuals produced in litters of three. Litters of three have the lowest sex ratio and approach nearest an expected condition, having suffered little or no prenatal mortality. This explanation is supported by a study of more than 100 litters with early partial absorptions which gave the high sex ratio of 123.37.

67. *A note on the relation of the auricle and external auditory canal to drum-membrane mechanics.* A. G. POHLMAN, Saint Louis University.

The writer presented certain comparative data at the last meeting of the Association on the problem of middle-ear mechanics. This evidence favored the 'string-telephone' theory of sound transmission and opposed the usually accepted theory of mass reactions. Practically all modern writers (Wrightson-Keith and Zimmermann excepted) agree that the drum membrane-ossicular chain route is the highly efficient one for so-called 'bone-transmitted' sound. Modern investigators of cochlear mechanics with few exceptions base the responses in the inner ear upon mass movements in the periotic fluid (functional relation of stapes basis to fenestra cochleae). It is essential that the reactions in the drum membrane to energies of optimum or minimum force be carefully studied. It appears that

the dampening-out effect of the external auditory canal upon the sound pulses entering the external meatus through diffraction is more than compensated through the action of the auricle. An explanation of the Weber phenomenon or the Rinne-negative ear test does not appear satisfactory on the basis of the mass response conception. The increased efficiency of bone-transmitted sounds (mastoid and teeth) and the decreased efficiency of air-transmitted sound in pathological conditions of the middle ear is more readily explained by the 'string-telephone' theory. This is also the case in the interpretation of instances of voluntary contraction of the M. tensor tympani and the dampening-out effect of heightened drum-membrane tension due to plus pressure in the external canal. A definite conception of drum-membrane mechanics is essential to the correct analysis of inner-ear responses.

68. *The determination of the percentage of the organic content of bone.* H. E. RADASCH, Jefferson Medical College.

The percentage of the organic substance in compact bone is given as 32 to 33 per cent. How that was determined is not apparent from the general literature. In order to determine the real percentage and to try to find out, if possible, the methods used by the early observers, experiments were made in various ways. After carefully preparing pieces of femur, tibia, and fibula, one set of pieces was weighed, then calcined, then weighed again. The loss indicated the amount of incinerable organic substance in compact bone. At twenty to sixty years the average per cent found was 40.75. In the adult cat this green weight per cent was found to be 38.32 per cent, while in the rabbit (two-thirds grown) the average was 38.90 per cent. By other methods the moisture, alcohol-soluble and ether-soluble substances were removed and the fixed organic content determined. The average amount of moisture at twenty to sixty years is 8.42 per cent and the ratio of fixed organic substance to the dried bone is only 34.92 per cent. The average amount of alcohol-soluble material is 8.46 per cent and the ratio of the fixed organic substance to the extracted bone is 32.36 per cent. The average amount of ether-soluble substance is 9.27 per cent; the ratio of the fixed organic substance to the extractable bone averages 31.34 per cent. It seems, though, that the standard weight should be that of green bone, and if this be accepted, then the organic substance averages 40.75 per cent.

69. *The distribution of the acid cells of the stomach.* H. E. RADASCH, Jefferson Medical College.

It is customary to state that the acid cells are found in the cardiac and fundal portions of the stomach, but there seems to be no definite statement as to the point or region at which they cease to exist. It was, therefore, determined to make a sort of survey of the stomach so as to see if it were possible to give any definite boundary to the acid-cell distribution and also to note any difference in distribution. For this purpose human and rabbit stomachs were fixed in toto and then, when dehydrating in 85 per cent alcohol, were cut. A strip $\frac{1}{2}$ inch wide of the entire lesser curvature was first cut out, then one of the entire greater curvature and one of the ventral or dorsal surface, attempting to follow the long axis of the surface. These pieces (uncut) were then completely dehydrated, cleared in cedar oil and absolute alcohol (equal parts) and then pure cedar oil,

and infiltrated in paraffin and then blocked without cutting into segments. After the paraffin had hardened the long strips were then cut into pieces $1\frac{1}{2}$ to 2 inches long (the width of the cut of a Spencer microtome) and sectioned. Such long strips may readily be cut into shorter strips by using a safety-razor blade. The stomach of the rabbit was run through whole, and if it would fit into the microtome was sectioned whole. If too large, the stomach block was cut into two pieces and sectioned in that condition. It was intended to study the stomachs in the stillborn also, but the material at hand at the time was unsatisfactory, but this will be taken up later.

70. *The sublenticular portion of the internal capsule and the thalamic radiation to the temporal lobe.* S. W. RANSON, Northwestern University Medical School.

In dissections of the internal capsule its sublenticular portion is seen to be composed of two strata. The upper stratum, immediately beneath the lentiform nucleus, is formed by the temporopontine tract. These fibers run directly lateralward into the temporal lobe. The lower stratum forms the roof of the inferior horn of the lateral ventricle and is composed for the most part of the temporothalamic fasciculus of Arnold. This bundle emerges from the thalamus near the external geniculate body, and forms a large strand directed forward in the roof of the inferior ventricular horn. A few at a time these fibers curve outward and then somewhat backward into the white matter of the temporal lobe. Another and smaller bundle of fibers can be traced from the stratum zonale in an arched course around the thalamus following the tail of the caudate nucleus. Passing through the sublenticular portion of the internal capsule, this fascicle flattens out in the roof of the inferior horn of the lateral ventricle under cover of the ependymal lining and can be traced forward to the anterior part of the temporal lobe. It lies on the ventricular surface of Arnold's bundle, and may be designated as the fasciculus thalamotemporalis arcuatus. It was seen by Probst ('05) in the brain of a monkey with an experimental lesion in the thalamus and by the same observer in the brains of microcephalic idiots.

71. *The so-called hibernating gland.* A. T. RASMUSSEN, University of Minnesota.

For this structure many other names have been proposed: adipose gland, lipoid gland, cholesterin gland, brown fat, organ of hibernation, hibernating mass. From about fifty papers available, its history consists of four periods. I. 1670 to 1817, during which it was generally regarded as part of the thymus. II. 1817 to 1863, during which it was generally recognized as distinct from the thymus, but still as a haemopoietic gland. III. Since 1863 it has generally been classed as a form of adipose tissue which serves as reserved food. IV. Its internal secretory character has been emphasized during the last ten years and recently ('20) as a factor in the etiology of deficiency diseases. From the reports of others on over forty species of animals and personal examination of numerous marmots (in which this structure is prominent), it is clear that histologically there is no similarity between it and the thymus. There is no evidence of any haemopoietic function. It is also different from ordinary adipose tissue. The cells are rarely if ever unilocular. The nucleus is never flattened much. It never loses all its fat. During hibernation it supplies only about one-thirtieth of the material consumed, and hence, as far as bulk is concerned, is not an important

food reserve. While the cytoplasm of the cells is rich in small granules (in addition to the fat globules) and the organ surprisingly vascular, more careful cytological and physiological work must be done before its close relation to the supra-renal cortex, corpus luteum, or other ductless glands can be affirmed.

72. *On the growth in weight of the human body and its various parts and organs in the fetal period and its expression by empirical formulae.* RICHARD E. SCAMMON, University of Minnesota.

The growth in weight of the entire body in the fetal period presents, when plotted against total body length, a concave curve which may be expressed by the empirical formula, $Y = (aX)^b$, when Y is the weight of the body in grams, X is the total body length in cm., and a and b are empirically determined constants. The absolute weights of the trunk, the extremities, and the head also follow this course of growth and may be expressed by the same formula with modified constants. This form of growth is typical of almost all the organs of the body—certainly of the heart, kidneys, spleen, thymus, liver, stomach, pancreas, suprarenals, thyroid, eyeballs, brain, and spinal cord and, in all probability, of the lungs, testes, and uterus as well. The growth of these structures may be expressed by formulae of the same general form as that of body weight, although each appears as a minor variant of the common type. So far no evidence has been found of a grouping of these prenatal curves in categories comparable with the main classes of postnatal growth curves. Similar findings regarding the type of growth of the body and its parts and organs are obtained when weight is plotted against age in fetal months.

73. *The visual pathway and the paranasal sinuses.* J. PARSONS SCHAEFFER, Jefferson Medical College.

Recent clinical reports prompted me to undertake a more detailed study of the anatomic relationships between certain portions of the visual pathway and the paranasal sinuses than hitherto attempted in my work. An anatomic basis was sought for certain clinical manifestations. Some were cleared up, others remain obscure and require further study. It is well to recall that the optic nerve, the optic commissure, and the optic tract are formed in order by the same axones with cell bodies located in the retina and that, strictly speaking, one is dealing with a partially decussated brain tract, the fibers of which are medullated in the retro-ocular portion, but lack a neurolemma. Clinical findings are in accord with this. The portions of the visual pathway that particularly concern us here are the so-called optic nerve and the optic commissure. The great variations in size, shape, number, and type, and the variations in symmetry and asymmetry of the paranasal sinuses preclude any constancy in the topographic relationships with the optic nerve and the optic commissure. The sphenoidal sinuses and the posterior ethmoidal cells are of first importance in this connection; however, the other sinuses may be a factor. Very commonly the most intimate relationships exist.

Clinically it has been found that paranasal-sinus disease may give rise to ocular complications without external signs of orbital inflammation. Optic neuritis, neuroretinitis, phlebitis, etc., are encountered. More important, since it often occurs with but slight ophthalmoscopic change, is the occurrence of a central

scotoma. The scotoma may be unilateral or bilateral, the latter despite the fact that but one side may be affected. The above conditions may rapidly advance to a state of blindness. It is surprising, however, how rapidly these conditions clear up, even the blindness, if the optic manifestations are early recognized and paranasal-sinus treatment properly and efficiently carried out. Want of such recognition and treatment early means permanent blindness from optic-nerve atrophy. Here an appreciation of the topographic anatomy of the optic pathway and the paranasal sinuses is of the greatest importance to those dealing with the eye and the nose clinically. Apropos in this connection is the report of a prominent ophthalmologist who in consultation found a patient totally and permanently blinded by an ill-advised curettage of the sphenoidal sinus, resulting in complete destruction of the optic chiasm. The underlying anatomy of the foregoing clinical findings will be discussed. Lantern.

74. *Relation of nutrition to the oestrous cycle.* KATHARINE J. SCOTT AND HERBERT M. EVANS, University of California.

In the study of the oestrous cycles of several hundred rats, Long and Evans reported a very considerable variation in cycle length, although in over 80 per cent of some 2000 observations, cycles of six days or less were found. These observers had had occasion to note the immediate impairment of ovarian function by increased cycle length whenever experimental animals were submitted to one or more days of undernutrition. Papanicolaou and Stockard have now established similar facts on the delay of the next oestrous of guinea-pigs due to undernutrition. The suggestion was near at hand and was, in fact, made by the last-mentioned workers that the considerable variation in the length of the oestrous cycles observed in our colony of rats might be referable to chance nutritive deficiencies unintentionally and inevitably introduced by feeding table scraps. We have submitted this question to test by placing some twenty-one animals upon our usual 'table-scrap' rations and twenty-one litter mates upon a diet employed by McCollum and certified to have yielded excellent growth and reproduction in this species over a number of years. The McCollum diet consists of:

	<i>grams</i>
Wheat (whole)	67.5
Casein	15.0
Whole-milk powder	10.0
Sodium chloride	1.0
Calcium carbonate	1.5
Butter fat	5.0

The animals at all times had access to an abundance of the food and of fresh water. At the beginning of the observations all of the animals were about 100 days old and the observations to date have extended over fifty days, opportunity being thus afforded for the observation of ten or more normal oestrous cycles. During this period the rats on the standard ration made an average gain in weight of 49 grams; those on the table-scrap diet, a gain of 42 grams. The average length of all cycles observed in animals on either ration was the same and was almost exactly five days. In the case of both diets about half the animals exhibited an uninterrupted series of oestrous cycles of six days or less in length and in each group of twenty-one animals three or four individuals showed more marked

irregularity. Furthermore, two other larger groups of animals composed of ninety-five and seventy individuals, respectively, and of almost identical age but not litter mates were placed, the one on the standard ration, the other on table scraps, and a similar study of their oestrous cycles instituted. The data obtained were concordant with the above. It cannot be considered, therefore, that the irregularity which may be observed in the lengths of the oestrous cycles of young adult rats is always due to nutritive deficiency. We would not by this statement mean to deny the great importance of nutrition in maintaining the oestrous rhythm. Studies of the effect on the oestrous rhythm of experimental undernutrition both qualitative and quantitative are under way.

75. *The development of the pharynx, and the histology of its adult derivatives, in turtles.* RALPH F. SHANER, Harvard Medical School.

The pharynx of *Chrysemys marginata* develops five pouches. The last pouch, with the postbranchial body, arises from a common stem. There are six aortic arches and five nerve placodes. The second, third, and fourth pouches end secondarily in a common cervical sinus. The first three pouches have patent clefts. From the first pouch develops the auditory tube and the tympanic-mastoid cavity. The second bears a dorsal knob of doubtful significance, which vanishes with it. The third and fourth develop persisting dorsal and ventral outgrowths. The fifth develops a transient dorsal (thymic) rudiment and then disappears; the postbranchial is then attached to the fourth pouch. The thyroid gland develops entirely from a median ventral diverticulum. The dorsal and ventral outgrowths of the third pouch separate off as a single independent complex closely adherent to the carotid artery. The dorsal moiety becomes a large, lobulated, persistent, anterior thymus; the ventral one is transformed into an anterior parathyreoid, which is enclosed within the adult anterior thymus. The two outgrowths of the fourth pouch and the postbranchial body separate off as another independent complex, closely adherent to the systemic arch. The dorsal outgrowth persists as a variable posterior thymus; the ventral as a large posterior parathyreoid. The postbranchial body develops chiefly on the left side; it breaks up into numerous secretory vesicles. The three organs constitute the tiny aortic body, which appears in the adult, attached to the aorta. The lobules of each thymus are divided into cortex and medulla, the latter containing thymic corpuscles. Each parathyreoid is made up of cords of epithelial cells, surrounded by vascular sinusoids. The postbranchial vesicles are of two types and contain a definite secretion.

76. *The presence of a head cavity in a human embryo of 4 mm.* JOSEPH L. SHELL-SHEAR (introduced by G. L. Streeter).

The cavity is situated immediately posterior to the otic vesicle and mesial to the glossopharyngeal complex, and probably corresponds to Van Wijhe's 1st post-otic segment. Spindle-shaped cells arising from it are continuous with a clump of cells of a similar character situated mesial to the vagus complex. From this latter group of cells a migration is taking place which passes posterior to the vagus apparatus and is interpreted as the migration of the hypoglossal musculature.

The cavity is regarded as homologous with the head cavities which give rise to the eye musculature. This type of cavity is peculiar to the median somatic or axial mesoderm and distinct from the coelom which is formed by a splitting of the lateral somatic mesoderm.

77. *On the reaction of the living blood cells to dyes.* M. E. SIMPSON (introduced by H. M. Evans), University of California.

A drop of blood was caught on a cover and immediately brought in contact with a slide on which was a thin, dry film of dye. The method has been previously employed by Pappenheim, Rosin, and Bibergeil. Somewhat less than two hundred dye substances were carefully studied. The following generalizations may be made:

1. The dyes frequently collect in a definite set of granules, 'the segregation apparatus,' which can be differentiated from, 1) refractile granules (probably lipoid); 2) degeneration vacuoles; 3) specific granules, and, 4) mitochondria.

2. With some dyes a certain proportion of the granules enlarge rapidly, the vacuolar structures resulting therefrom having been described by Ferrata and termed 'plasmosomes.' But Arnold has used this term much more widely. Rosin and Bibergeil called them 'dye sphere formations.' They evidently correspond to what Renaüt termed 'grains de ségrégation' in the connective-tissue cells. Dubrueil called them 'vacuoles à grains de ségrégation;' Hammar referred to them as 'purpurgranula,' whereas Evans and Scott, in their study of the reaction of connective tissues to vital stains, described the same system of structures as 'the vacuolar apparatus.'

The segregation apparatus may be considered as a reaction on the part of the living cell for the purpose of segregating and isolating various foreign materials forced upon it. The ability to thus segregate dyes is common to all the white cells of the blood, but the extent of the segregation apparatus is characteristic for each cell type and may be used as a valuable point of distinction between the different kinds of mononuclear cells. The transitionals of Ehrlich or monocytes of Naegeli show the reaction to the greatest degree. Probably all dye groups contain members which would be handled in this way by the cell. The reaction is perhaps given most typically by certain of the oxazine, thiazine and azine dyes, but dyes showing the widest variation in chemical and physical properties appear to give this response.

78. *The ingestion of melanin pigment granules by tissue culture cells grown from the embryo chick in Locke-Lewis solution.* DAVID T. SMITH (introduced by W. H. Lewis), Carnegie Laboratory of Embryology.

In cultures of chick embryos, melanin pigment granules from the retina of the chick, pig, dog, and man (newborn child) were taken in by clasmatocytes, fibroblasts, endothelial cells, white blood cells, and cells from lung, liver, kidney, intestine, and amnion by a process which appears quite different from that by which the amoeba ingest food. Peripheral nerve cells, striated muscle cells, and red blood cells did not ingest the granules. When a granule was free in the culture fluid it exhibited both Brownian movement and an actual progression from place to place; when attached to the cell wall it was motionless; after passing into the cytoplasm it displayed the jerky motion characteristic of pigment

granules in the true pigment cells, and finally, when a vacuole developed about a granule it reverted to Brownian motion. The granules were not taken into preformed vacuoles; but later, as they moved back and forth in the cytoplasm, a vacuole developed about each one or about each small clump of granules. The granules then exhibited Brownian movement, became swollen, disintegrated, and were reduced to debris.

Granules in the true pigment-producing cells are always individual and discrete bodies of about the same size and shape. The individuality and discreteness are common properties, but size and shape vary in cells of different origins. The granules in normal pigmented cells are never found clumped into vacuoles or broken up into debris. It can therefore be determined by the appearance of the granules whether they have been produced or ingested by the cell. This fact should help us to settle the old question of pigment-producing versus pigment-carrying cells.

79. Some modifications induced by parabiotic union of the hypophysectomized to the normal tadpole. PHILIP E. SMITH, University of California.

It appears of interest to determine whether the disturbances resulting from early hypophysectomy in the tadpole may be modified by a vascular interchange between the normal and the pituitaryless individuals, and to observe any compensatory alterations that may occur in the normal member of the pair. Hypophysectomized individuals were united at an early stage (5 mm.) to normal larvae. Both members of four pairs completed metamorphosis, and several pairs reached a nearly maximal larval size. In every case the pigmentary and endocrine disturbances typical of hypophysectomy were modified. Albinism, though evident, was only partial. Examination of the living animal and of cutaneous whole mounts revealed the fact that the xantholeucophores were not as broadly expanded, the epidermal melanophores not as scanty in number, as poor in melanin content, nor as contracted as in the typical hypophysis-free tadpole. The thyroids of the albinous member, instead of being diminutive, as would otherwise have been the case, were nearly normal in size, while those of the normal mate exhibited a slight hypertrophy. The adrenal cortex while reduced did not appear to suffer the same great reduction as that which normally occurs in the typical Albino. The vascular interchange did not modify the greatly reduced and atypical neural lobe of the Albino, nor did it appear to have caused an hypertrophy of the hypophysis of the normal member of the pair.

80. Upon the essentiality of the buccal component of the hypophysis for the continuance of life. PHILIP E. SMITH, University of California.

The above-mentioned parabiotic pairs were united in several ways, one of which, a union of the corresponding sides of the tail-stalks, is of especial interest here. Two such pairs completed metamorphosis. It is obvious that the attachments would be severed by metamorphosis. One pair completely separated; in the other an atrophic connecting strand persisted. Both members of each pair displayed the usual activity up to three or four days prior to the completion of metamorphosis. The hypophysectomized members then became more sluggish and exhibited a slowed respiration. One of them died just after the separation, the other just before the separation would have taken place. The separation

in no way embarrassed the normal member of either pair. These members displayed their usual activity. In two other pairs joined by their heads, metamorphosis did not result in the death of the hypophysectomized specimen, probable due to the persistence of the vascular interchange.

Mammalian experimentation appears to have established the fact that the neural lobe is not essential to life. The essentiality of the anterior lobe has been questioned, death from its removal being referred by some to injury of the neighboring structures, not to hypophysial deficiency. In this experiment there was no injury to the brain or other neighboring structures, yet the animals promptly died when, in the adult stage, they were deprived of the secretion of the buccal hypophysis. The functional similarity which experimental work has shown to exist between the parts of the amphibian and mammalian hypophyses makes it highly probable that this component is essential for life in the mammal as well.

81. *Does the administration of anterior lobe to the tadpole produce an effect similar to that obtained from thyroid feeding?* PHILIP E. SMITH AND GARNETT CHENEY, University of California.

In a recent paper Hoskins and Hoskins have advanced evidence showing that the administration of a commercial anterior-lobe preparation to the normal and thyroidless tadpole gives an effect similar to that which is characteristic for thyroid administration, i.e., causes metamorphosis. This evidence would indicate that the anterior lobe and the thyroid are in this respect functionally similar, and so supports the hypothesis that they may function vicariously. These results are at variance with those obtained by fresh anterior-lobe feeding. We have found that the feeding of the particular commercial preparation used by the Hoskinses gives the results obtained by them. Two other commercial preparations, the dried gland prepared in this laboratory and the fresh gland, failed to give similar effects. Analysis by Doctor Kendall showed that this commercial preparation contained iodine greatly in excess of the normal amount.

Iodine as KI was added to the dried gland prepared in this laboratory in a sufficient amount to give an iodine content identical with this commercial product. Tadpoles receiving this substance did not exhibit a decisive acceleration of metamorphosis. In another case iodine as thyroxine iodine was added in identical amounts. Normal and thyroidless tadpoles receiving this substance paralleled in development the animals fed with the commercial preparation in question. The evidence indicates that a similarity of response is not evoked by thyroid and hypophysial administration. The anterior-lobe preparation used by the Hoskinses contained an unusual amount of iodine and displayed an altogether unique activity.

82. *On the presence of longitudinal collector nerves in the tail of the skate and dogfish.* CARL CASKEY SPEIDEL, University of Virginia.

In the tail of the skate there are present four longitudinal collecting nerve trunks. These extend throughout the tail, but are not present in the body proper. They are located two on each side of the vertebral column, close to the bodies of the vertebrae. The dorsal collector on each side is opposite the junction of the neural arch and centrum of each vertebra. The ventral collector on each side is opposite the junction of the haemal arch and centrum of each vertebra.

These collectors are fed regularly by the spinal nerves according to the following system: the ventral root from the spinal cord unites with the dorsal root emerging from the succeeding intervertebral foramen. From this junction emerge two rami, one of which connects with the dorsal collector, the other with the ventral collector. Branches to the muscles and electric organs are given off from these rami. No branches were found from the collectors to the electric organs. Small branches from the collecting trunks to the blood-vessels led to the supposition that they might represent a sort of primitive sympathetic system, a forerunner of the sympathetic system of higher vertebrates. Osmic-acid preparations, however, showed no non-medullated fibers. All the nerve fibers were medullated. Similar collecting nerve trunks have been found in the tail of the dogfish and shark, although the connections with the spinal nerves were somewhat different.

83. *Comparative study of large irregular cells in the spinal cord of other fishes homologous to the giant glandular cells in the spinal cord of the skates.* CARL CASKEY SPEIDEL, University of Virginia.

In the caudal portion of the spinal cord of the skate there are present large irregular cells of glandular character. Cells homologous to these have been found in more than thirty genera of fishes. These include both fresh- and salt-water forms, and represent the elasmobranch, teleost, and ganoid fishes. In three genera of fishes the cells were not found. In most of the forms the cells are neither so conspicuous nor so active as in the skate. Granular secretion is usually scanty or lacking. A form of special interest is the summer flounder in which the cells are extraordinarily large and numerous. This unusual type of cell, then, may be said to occur in the great majority of fishes, reaching its greatest degree of development in the skate and flounder. A doubtful homologous cell has been found in the ventral nerve cord of the lobster, but not in the horseshoe crab. In none of the vertebrates higher than fishes have the cells been found.

84. *Experiments on the development of the cranial ganglion and the lateral-line sense organs in Amblystoma.* L. S. STONE (introduced by R. G. Harrison), Yale University.

These experiments involve the removal of placodes and neural-crest cells. In normal development the crest cells migrate ventrally over the mesoderm of the visceral arches, around which they wrap themselves, and finally become situated on their median surfaces, where they form the visceral skeleton. The appearance of a few mesodermal yolk granules among the crest-cell aggregations gives one the impression that there may be a slight mesodermal contribution to the visceral skeleton. When the crest cells are removed, a few cases show an incomplete formation of the visceral skeleton, but no defects in the ganglionic components are observed due either to the fact that they may take no part in the formation of the ganglia or to the difficulty in eliminating the crest cells on account of their persistent ability to regenerate. All groups of lateral-line organs have separate primordia, except possibly the maxillary group, which may be a branch of the ventral hyomandibular. When sheets of ectoderm, taken anterior and posterior to the position of the ear, are removed at the closure of the neural folds, the body lines, occipital and supra-orbital primordia and their corresponding

lateral line ganglia are absent. Removal of the epibranchial placodes of VII, IX, and X produces small ganglia apparently lacking visceral sensory and cutaneous components. Placodes of vagus and facial lateral-line ganglia interchanged produce in their new positions irregular groups of many sense organs innervated by fibers from lateral-line ganglia in the transplanted region.

85. *A well-preserved human embryo of the presomite period.* GEORGE L. STREETER, Department of Embryology, Carnegie Institute of Washington.

Lantern slides will be shown of a young human embryo which was found at autopsy by Dr. H. G. Weiskotten, of Syracuse University. The patient, twenty years old, having skipped one menstrual period, died after an extensive pelvic retroperitoneal hemorrhage, presumably originating from an attempt to induce an abortion. The embedded ovum was found in the fundus of the uterus, and, together with the adjacent portion of the uterine wall, was placed in 10 per cent formalin seven and one-quarter hours after the death of the patient. Due to the handling of the specimen during its removal, the ovum and its decidual capsule were partially loosened from the implantation site and apparently flattened, but otherwise the specimen appears to be normal and in an excellent state of preservation. The external diameters of the decidual capsule are $16 \times 12 \times 5.3$ mm. The diameters of the chorionic cavity are $9 \times 7.3 \times 2$ mm. The embryo, i.e., the yolk-sac and amniotic vesicle combined, measures $2.2 \times 2.1 \times 1.2$ mm. The greatest width of the embryonic shield is slightly less than 1 mm. On account of its being bent upon itself, the length cannot as yet be accurately stated. The general form of the embryo and the character of the chorionic villi will be shown in the slides.

86. *The order, time, and rate of ossification of the skeleton. II. Mammals.* R. M. STRONG, Loyola University School of Medicine.

The white rat has been the type used for most of the mammalian portion of this work to date. The results contain too many details for the space allowed in an abstract. Some of them are mentioned here: A series of features of the skull, girdles, and long bones have been studied. Stages from the first appearance of ossification to senility (730 days) have been compared.

As in the bird, beginning ossification occurs in several bones at about the same time. The first ossification stages occur fully a week later in rat embryos than in the chick. At seventeen days and fifty-five minutes after insemination, ossification was found well started in the mandible, clavicles, and in the second to eleventh ribs. It had also begun in the maxilla, palatine, premaxilla, orbital portion of the frontal, humerus, radius, and ulna. The scapula showed ossification at seventeen days and eight and one-fourth hours. This had extended to a large portion of the spine several hours later. An ossification center was found in the coracoid process at three days after birth, and fusion with the scapula early in the fourth month. Ossification centers appear in the ilium, femur, tibia, and fibula at eighteen days nine and a half hours. They appear in the ischium and pubis at nineteen days eight and three-fourths hours. In the same embryo, the deltoid crest is well started, and it resembles the adult form a day later. Except for changes in size and general form, the rat skeleton is essentially mature at the end of the first year. Only slight stages take place after the third month.

87. *Situs inversus in double trout.* F. H. SWETT, Yale University.

Examination has been made of the situs viscerum in fifteen double trout embryos and the findings resolve themselves into the following classes: In nine cases the situs viscerum of both components is normal; in one, that of A (the right twin) is reversed; in two, B (the left twin) is reversed, and in three B is normal, A of indeterminate situs. One of the cases which shows situs inversus in component B is of the auto site-parasite type and it is the parasite which is reversed. A definite correlation between the amount of external or internal doubling and the occurrence of situs inversus cannot be demonstrated.

88. *The relation of the pars intermedia of the hypophysis and the pineal gland to pigmentation changes in anuran larvae.* W. W. SWINGLE (introduced by R. G. Harrison), Yale University.

Homoplastic and heteroplastic transplants of the pars intermedia of the hypophysis from adult frogs of the species *Rana catesbeiana*, *Rana clamitans*, and *Rana pipiens* were made into bullfrog tadpoles of various ages and sizes. The effect upon growth and metamorphosis of the animals was negative, but pigmentation changes following transplantation of the tissue were very marked. Within twenty-four hours after engrafting the pars intermedia either intraperitoneally or into the abdominal lymph spaces the larvae became deeply pigmented, changing color from a light yellow to almost black. The color change is due to marked expansion of the melanophores of the skin, though the deeper-lying pigment cells of the tadpole also expand. The increased pigmentation lasts as long as the engrafted pituitary tissue remains functional and is not resorbed. Following resorption of the graft, the animals resume normal coloration. The environment apparently plays no part in the color change following transplantation of the pars intermedia; the change is due to the stimulating effect of the hormone either directly upon the melanophores or else indirectly through the intermediation of the nervous system.

There is a possible interrelationship of the pars intermedia to the pineal gland in the production of pigmentation changes in anuran larvae. Darkly pigmented tadpoles engrafted with the pineal gland of reptiles (*Chelonia*) change color within an hour following transplantation; the expanded melanophores contract and the animals become lightly pigmented. This condition persists for several hours; then slowly normal pigmentation is resumed. Similar changes follow introduction of desiccated mammalian pineal tissue into body cavity.

89. *Mammalian pubic metamorphosis.* (Stereo-lantern.) T. WINGATE TODD, Western Reserve University.

In comparing skeletal growth and metamorphosis of man with similar features in other mammals, it is necessary to utilize some standard subdivision of the total life period. In our present work the best subdivision is the following:

- 1st life period. Terminates in complete union of the acetabular elements.
- 2nd life period. Terminates in complete union of epiphyses with long bones.
- 3rd life period. Terminates in complete union of epiphyses with vertebral centra.
- 4th life period. Between the termination of the 3rd and the commencement of the 5th period.

5th life period. Commences with lipping of the glenoid margins of the scapulae.

6th life period. Commencement of senile (quasipathological) erosions and osteophytic growths at joints, and senile textures of bones.

These features, unlike eruption of teeth, closure of cranial sutures and others not here mentioned, present definite relationships to the total life period. Compared with each other they do not represent even approximately equal time relationships. Judged by these standards, it is possible to observe the delay in commencement and still more in completion of pubic metamorphosis as evidenced by higher mammals and by man. At the same time the gradual evolution of the features of this metamorphosis can be studied. Its progressive features are exemplified in members of some orders, other members of which show retrograde conditions. Man falls into the latter group.

90. *The skull as a closed box.* LEWIS H. WEED AND WALTER HUGHSON, Johns Hopkins Medical School.

The experiments of Weed and McKibben, reported two years ago, demonstrated that the pressure of the cerebrospinal fluid may be markedly lowered and frequently reduced to negative values by appropriate intravenous injections of strongly hypertonic solutions. These findings suggested that the cerebrospinal axis was enclosed within a rigid system, but absolute proof of the 'closed-box' character of the coverings was lacking. Experiments recently performed indicate that if the bony calvarium on one side be removed without opening the dura mater and if the pressure of the cerebrospinal fluid be taken, repeated intravenous injections of strongly hypertonic solutions fail to reduce the pressure to below zero. Likewise, if the bony calvarium on one side be opened and then temporarily sealed, appropriate intravenous injections of the hypertonic solutions will reduce the pressure of the cerebrospinal fluid to negative readings. Under these circumstances, opening the cranial cavity by removal of the sealing device will cause the pressure of the fluid to become immediately positive, the level of the positive pressure being determined by the hydrostatic height of the brain above the needle. These experiments can be explained only upon the hypothesis that within minimal limits the cranium and vertebral canal form a closed system within which lies the central nervous system.

DEMONSTRATIONS

1. *The motor cortex of the brain of the sheep.* CHARLES BAGLEY, JR., Johns Hopkins University.
2. *The development of connective tissue.* GEORGE A. BAITSELL, Yale University.
3. a—*De-electrification of paraffin ribbon.* b—*Differential bone stains for macroscopic transparent preparations.* O. V. BATSON, University of Wisconsin.
4. *Injection of blood vessels of the lung of the chick during third day of incubation to show the origin of pulmonary veins.* CHARLES E. BUELL, JR. (introduced by Florence R. Sabin), Johns Hopkins Medical School.
5. *Plates of a radiographic atlas of anatomy.* H. S. BURR, Yale University, School of Medicine.

6. *Model of the principal fiber tracts of the central nervous system.* J. L. JACKOWITZ (introduced by H. S. Burr), Yale University, School of Medicine.
7. *Microscopic slides, drawings and graphs illustrating bone, muscle and joint origin in the thigh of the pig (Sus scrofa).* EBEN J. CAREY, Marquette School of Medicine.
8. *Sections illustrating the effect of stress and strain upon the healing of bone injuries.* ELIOT R. CLARK and RALPH R. WILSON, University of Missouri.
9. *Digestion of different proteins by the mesenchyme and its derivatives in the tadpole.* VERA DANCHAKOFF, Columbia University.
10. *Various techniques used in scientific illustration.* ERWIN F. FABER, University of Pennsylvania.
11. *Preparations showing the absorption and assimilation of fat.* SIMON H. GAGE, Cornell University.
12. *A case of hermaphroditism in the pig.* HARLEY N. GOULD, Lake Forest College.
13. a—*Thyreo-parathyroidectomised and parathyroidectomised albino rats.* b—*Effects of removal of the thyroid apparatus on bone growth of albino rats.* c—*Malformation of the femur and humerus accompanying abdominal tumor in a female albino rat.* FREDERICK S. HAMMETT, The Wistar Institute.
14. *Injected pig embryos cleared by the Spalteholz method to show the development of the innominate artery.* CHESTER H. HEUSER, Johns Hopkins Medical School.
15. *Demonstration of the value of x-ray in anatomical teaching and research.* EBEN C. HILL, Johns Hopkins Medical School.
16. *Regenerative processes in the spinal cord of frog larvae severed previous to metamorphosis.* DAVENPORT HOOKER, University of Pittsburgh.
17. *Section cutting of the dental tissues by means of the ether-vaporizing microtome.* A. HOPEWELL-SMITH, University of Pennsylvania.
18. *Stereoscopic photographs of human embryos.* N. WILLIAMS INGALLS, School of Medicine, Western Reserve University.
19. *Sections of chick embryos showing ganglia of the sympathetic trunks derived from cells which advanced peripherally along the fibers of the ventral nerve-roots in segments in which the spinal ganglia and dorsal nerve-roots are absent.* ALBERT KUNTZ, St. Louis University.
20. *A method for preserving cadavers in the dissecting-room.* FREDERIC P. LORD, Dartmouth Medical School.
21. *Histological preparations showing various stages in lactation and subsequent involution of the mammary gland in the albino rat.* L. M. A. MAEDER (introduced by C. M. Jackson), University of Minnesota.
22. *Microscopic sections showing functional variations in normal human mammary glands.* JOSEPH MCFARLAND, University of Pennsylvania.
23. *Cleared preparations illustrating the involution of the mammary gland in the female albino rat.* FRANK J. MYERS (introduced by J. A. Myers), University of Minnesota.
24. a—*A graph illustrating simple formulae for correlating crown-heel and crown-rump length in fetal life.* b—*Material illustrating the developmental topography of the thymus with particular reference to the changes at birth and in the neonatal period.* GUSTAVE J. NOBACK, University of Minnesota.
25. a—*Wax reconstruction of the nuclear masses in the brain stem of a sheep.* JAMES W. PAFEZ, Cornell University.

26. *b—Wax reconstruction of the olivary nuclei of the sheep, rabbit, dog and bear.*

JAMES W. PAPEZ, Cornell University.

The inferior olivary nucleus of the rabbit, sheep, dog and bear is divisible into the dorsal, ventral and intermediate olivary nuclei and the olivary sac. The dorsal nucleus is an oval plate that lies dorsal to the sac and is secondarily separated from its dorsal lip. The ventral nucleus is a thick oval plate that extends the entire length and with the intermediate nucleus forms the caudal end of the olivary complex. Orally its medial margin is secondarily separated from the ventral lip of the sac. The intermediate nucleus is formed of three parts; the paramedian plate at the caudal end of the complex united with the ventral nucleus, the intermediate plate extending laterally to the caudal end of the ventral lip of the sac, and the olivary bridge extending from the paramedian plate laterally to join the narrow caudal ends of the dorsal nucleus and sac. The olivary sac is a simple oval sac, compressed dorsoventrally with its opening towards the mid line. The sac is situated in the oral portion of the olivary complex where it intervenes between the dorsal and ventral nuclei. The hypoglossus nerve perforates the dorsal nucleus and lateral end of bridge and in the rabbit also the sac. The larger oral portion of the olivary nucleus appears to have been rotated laterally in the expanded portion of the bulb while the caudal portion has retained a more fixed position oral to the decussation of the cerebrospinal tracts.

27. *Materials in a case of multiple atresia of the jejunum of a young child suggesting etiological factors.* C. W. M. POYNTER, University of Nebraska Medical College.

28. *a—Field graphs, curves and charts illustrating the growth of the various external dimensions of the human body in the fetal period.* L. A. CALKINS (introduced by R. E. Scammon), University of Minnesota.

29. *b—Material illustrating the growth of the brain and its parts and of the spinal cord in the fetal period of man.* H. L. DUNN (introduced by R. E. Scammon), University of Minnesota.

30. *c—Graphs and charts illustrating the growth in weight of the body as a whole and its various parts and organs in the fetal period of man.* R. E. SCAMMON, University of Minnesota.

31. *Histological preparations of experimentally doubly-ligated blood vessels, showing the fate of the contained blood and the behavior of the intima.* J. PARSONS SCHAEFFER and H. E. RADASCH, Jefferson Medical College.

32. *A series of graphs illustrating the changes in the form of the thorax at birth and in the neonatal period.* RICHARD E. SCAMMON and WILLIAM E. RUCKER, University of Minnesota.

These graphs are based upon measurements of the chest in fetuses, full-term children and a series of infants less than two weeks old. The horizontal chest circumference is greatly increased with the first inspiration, but in the course of the first 24 hours enters a period of decrease which continues for three or four days. Following this is a second phase of circumference gain which continues throughout the remainder of the period of observation. The diameters of the thorax undergo changes similar to those of the chest circumference. The thoracic index stands below 90 in the latter part of the fetal period, but it rises to an average of about 106 with the establishment of respiration, and then drops

to about 102 in the first 24 hours. Thereafter it declines irregularly to about 100.5 in the middle of the second postnatal week.

33. *Cinematomicrography of serial sections.* W. F. SCHREIBER, STACY R. GUILD, and L. G. HERRMANN, Anatomical Laboratory, University of Michigan.

34. *Histological preparations showing the effects of inanition upon the development and structure of the testis in the albino rat.* DAVID M. SIPERSTEIN (introduced by C. M. Jackson), University of Minnesota.

35. *Model illustrating the effect on the growth of the sacrum following early removal of the posterior limb-bud in chick embryos.* R. G. SPURLING (introduced by E. R. Clark), University of Missouri.

36. *Charts showing the weight of the ovaries during the reproductive cycle in albino rats.* a—During gestation; b—During normal lactation; c—In females deprived of their litter at birth. J. M. STOTSENBERG, The Wistar Institute.

37. *Unique case of ectopic pregnancy.* G. L. STREETER, Carnegie Laboratory of Embryology.

A chorionic sac containing a normal human embryo of about eight weeks development which was obtained by operation from the subcutaneous tissue superficial to the rectus muscle midway between the umbilicus and the pubis.

38. *Cleared embryos and postembryonic stages.* R. M. STRONG, Loyola University School of Medicine.

39. *Free costal bars of the epistropheus of an adult man.* PAUL K. WEBB (introduced by R. J. Terry), Washington University School of Medicine.

This rare variation is interpreted as further evidence of the tendency to reduction and special modification of the vertebrae at the cranial end of the column.

40. *Anomalous right subclavian artery in man.* WILLIAM A. HUDSON (introduced by R. J. Terry), Washington University School of Medicine.

The relation of this variant to the oesophagus and the presence of an 'aneurysmal' swelling at its origin have been regarded as possibly causing dysphagia in the subject; it is suggested that the pressure of the anomalous vessel upon the thoracic duct may be a factor in the incidence of slow starvation recorded in connection with this variation. Absence of a right recurrent nerve and origin of the inferior laryngeal directly from the vagus is of practical interest in the operations for goitre.

41. *Chondrocranium of *Caluromys philander*.* Wax plate model from a 17 mm. embryo. WALCOTT DENISON and R. J. TERRY, Washington University School of Medicine.

Of special interest are: the shallow pituitary fossa and rudimentary dorsum sellae; absence of a true optic foramen; high degree of independence of the nasal capsules; presence of paired vomers; an unpaired nasal ossicle (os carunculæ).

42. *Vitally stained polymorphonuclear leucocytes in the placenta.* GEORGE B. WISLOCKI, Johns Hopkins Medical School.

CONSTITUTION

ARTICLE I

Section 1. The name of the Society shall be "The American Association of Anatomists."

Sec. 2. The purpose of the Association shall be the advancement of anatomical science.

ARTICLE II

Section 1. The officers of the Association shall consist of a President, a Vice-President, and a Secretary, who shall also act as Treasurer. The President and the Vice-President shall be elected for two years, the Secretary for four years. In case of absence of the President and Vice-President, the senior member of the Executive Committee shall preside. The election of all the officers shall be by ballot at the annual meeting of the Association and their official term shall commence with the close of the annual meeting.

Sec. 2. At the annual meeting next preceding an election, the President shall name a nominating committee of three members. This committee shall make its nominations to the Secretary not less than two months before the annual meeting at which the election is to take place. It shall be the duty of the Secretary to mail the list to all members of the Association at least one month before the annual meeting. Additional names for any office may be made in writing to the Secretary by any five members at any time previous to balloting.

ARTICLE III

The management of the affairs of the Association shall be delegated to an Executive Committee, consisting of eleven members, including the officers. Two members of the Executive Committee shall be elected annually and, so far as possible, election of members of the Executive Committee shall be in proportion to the geographical distribution of members. Five shall constitute a quorum of the Executive Committee.

ARTICLE IV

The Association shall meet at least annually, the time and place to be determined by the Executive Committee. The annual meeting for the election of officers shall be the meeting of convocation week, or in case this is not held, the first meeting after the new year.

ARTICLE V

Section 1. Candidates for membership must be persons engaged in the investigation of anatomical or cognate sciences, and shall be proposed in writing to the Executive Committee by two members, who shall accompany the recom-

mentation by a list of the candidate's publications, together with references. Their election by the Executive Committee, to be effective, shall be ratified by the Association in open meeting.

Sec. 2. Honorary members may be elected from those who have distinguished themselves in anatomical research. Nominations by the Executive Committee must be unanimous and their proposal with a reason for recommendations shall be presented to the Association at an annual meeting, a three-fourths vote of members present being necessary for an election.

ARTICLE VI

The annual dues shall be seven dollars. A member in arrears for dues for two years shall be dropped by the Secretary at the next meeting of the Association, but may be reinstated at the discretion of the Executive Committee on payment of arrears.

ARTICLE VII

Section 1. Twenty members shall constitute a quorum for the transaction of business.

Sec. 2. Any change in the constitution of the Association must be presented in writing at one annual meeting in order to receive consideration and be acted upon at the next annual meeting; due notice of the proposed change to be sent to each member at least one month in advance of the meeting at which such action is to be taken.

Sec. 3. The ruling of the Chairman shall be in accordance with "Robert's Rules of Order."

The orders adopted by this Association, which read as follows, have not been altered:

Newly elected members must qualify by payment of dues for one year within thirty days after election.

The maximum limit of time for the reading of papers shall be fifteen minutes.

The Secretary and Treasurer shall be allowed his traveling expenses and the sum of \$10 toward the payment of his hotel bill, at each session of the Association.

That the Association discontinue the separate publication of its proceedings and that the Anatomical Record be sent to each member of the Association, on payment of the Annual Dues, this journal to publish the proceedings of the Association.

AMERICAN ASSOCIATION OF ANATOMISTS

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